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The British Journal of Surgery

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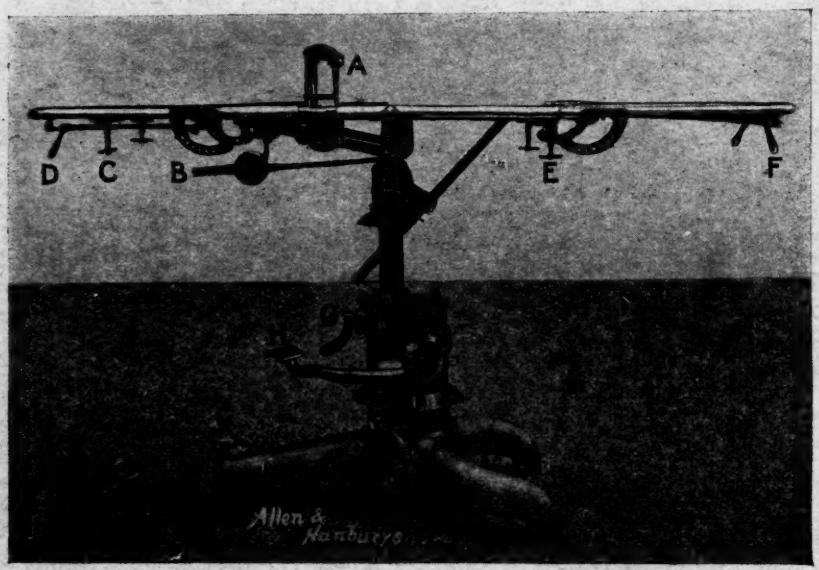

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JOHN HILTON.

1805–1878.

JOHN HILTON was born at Sible Hedingham, a small village on the river Colne in the heart of Essex, on September 22, 1805, the eldest son of John and Hannah Hilton. At the time of his birth his father and mother were in humble circumstances, but his father afterwards made money by the straw-plait industry, became the owner of some brick-fields, and built the house in Swan Street which is still called Hilton House. In addition to John Hilton, the family consisted of a brother, Charles, who inherited his father's property, and two sisters, one of whom married Charles Fagg on December 27, 1836.

Hilton was educated at Chelmsford and afterwards at Boulogne. He became a student at Guy's Hospital about 1824, and was admitted a Member of the Royal College of Surgeons of England in 1827. During his student career Guy's separated from St. Thomas's Hospital, a divorce which caused feelings to run so high that Sir Astley Cooper challenged Dr. Cholmeley—a member of his own staff—to meet him hostilely. Dr. Cholmeley, acting under the pressure of his friends, signed an apology, which was read publicly in the Lecture Theatre by Bransby Cooper, and the duel was prevented.

Hilton had so far made his mark during his student career that in 1828 he was elected a Demonstrator of Anatomy, the Professor of Anatomy being Bransby Cooper, and his fellow demonstrator being Edward Cock. The two demonstrators worked together in friendly rivalry, and when, at the suggestion of Sir Astley Cooper, they undertook an investigation upon the origin and distribution of the superior laryngeal nerve, Cock devoted himself chiefly to the comparative anatomy side of the question, whilst Hilton dealt with it from the anthropotomic aspect. The results of this work contributed largely to his election as a F.R.S. in 1839.

From 1828 Hilton devoted himself so assiduously to the labours of the dissecting room as to acquire the soubriquet of 'Anatomical John.' He appeared to live in the 'rooms,' and when he was not dissecting and teaching he was making post-mortem examinations, with the result that after sixteen years' experience he had gained an unrivalled knowledge of the anatomy of the human body and had become a first-rate teacher and lecturer. About 1838 he was engaged in making those dissections which, modelled in wax by Joseph Towne, still remain as gems in the museum of Guy's Hospital and in a few other anatomical collections. For this purpose Hilton devoted an hour or two every morning to a most careful dissection of a very small part—merely one or two inches—of some region on which he was engaged. He then left, and Towne, with like accuracy and faithfulness, copied the dissection. Towne, as is well known, worked alone and in a locked room, and the secrets of his art died with him. In process of time Hilton was appointed to give demonstrations on morbid anatomy in the Medical School, but it was not until 1845 that he was elected Lecturer on Anatomy, and he resigned the post in 1853.

As a lecturer and teacher Hilton was admirable, for he had the power of interesting the students by putting the trite and oft-told facts of anatomy in a totally new light as a result of his own observation and experience. He combined, too, elementary physiology with his teaching of anatomy, for as yet there was no separation between the two subjects. He was, however, a confirmed teleologist, and sought to prove that anatomical distribution was due to design rather than to development, and he seems to have had neither the education nor the inclination to appreciate the scientific aspects of anatomy.

He was elected Assistant Surgeon to Guy's Hospital in 1844, Callaway and Cock being his colleagues, and Morgan, Aston Key, and Bransby Cooper the full surgeons. He thus had the distinction of being the first surgeon to one of the large London hospitals

who was appointed without having served an apprenticeship either to the hospital or to one of its surgeons. In 1847 James Paget was elected to a similar position at St. Bartholomew's Hospital without either of these qualifications, and the rule, previously looked upon as inviolate, afterwards became more honoured in the breach than in the observance. The probationary period in the out-patient room was not of long duration, for Aston Key died after an acute illness lasting only twenty hours in 1849, and Hilton, as the Senior Assistant Surgeon, was promoted into his place.

The system was radically bad : for years Hilton had devoted his energies to anatomy, and never had the charge of any surgical case, as there were no smaller hospitals where he could gain experience ; then for five years he treated out-patients, but, except during the rare absences of his senior colleague, he had no care of beds ; lastly, at the age of 44, he was suddenly placed in a position of great surgical responsibility both as regards the practice and teaching of surgery. It is greatly to his credit, therefore, that he rapidly developed into an efficient surgeon, though he never acquired the brilliancy or expertness of the masters of surgery who had been trained from their youth upwards in the operating theatres of the great hospitals of the kingdom. The very exactness of Hilton's anatomical knowledge stood him in good stead, for it made him cautious where the brilliant surgeon was bold. His caution is still remembered by that method of opening deeply-seated abscesses with a probe and dressing forceps, after making a skin incision, which is known as 'Hilton's method.' He shone especially in his clinical lectures, where he had the power of bringing out the importance of every detail in a case, and of linking together as he went along a series of facts in each clinical report until they formed a continuous chain which kept the idlest student interested in what he was saying. As a teacher he attracted to himself the best type of student in the Medical School, and a dressership to Hilton was considered a blue ribbon at the Hospital. Pye-Smith, Taylor, Goodhart, Savage, Durham, Howse, and Davies-Colley were proud to remember in after life that they had served under him. Yet he was no easy master to serve, for he was rough in speech and was prone to indulge in personalities which hurt the *amour propre* of those to whom they were addressed.

At the Royal College of Surgeons he was elected a Fellow in 1843, and was chosen a Member of the Council in 1854 ; as Professor of Human Anatomy and Surgery he lectured from 1859 to 1862, but it was not until 1865 that he became a member of the Court of Examiners, a post he held for ten years. He served as Vice-President in 1865 and 1866. He became President in 1867, and delivered the Hunterian Oration in the same year. In 1870 he resigned the lectureship on Surgery at Guy's Hospital, though he still continued to practise in New Broad Street, E.C. In 1871 he was appointed Surgeon Extraordinary to Queen Victoria, and in the same year he filled the office of President of the Pathological Society of London. He was twice married, and his children survived him. He died at Clapham of cancer of the stomach on September 14, 1878.

No one looking at Hilton, it is said, would have thought that he had a great surgeon before him. He seemed much more like a prosperous City man. Short, rather stout and dapper, in a plain frock coat, with a faultless shirt front, a black stock or bow-tie, a fancy waistcoat festooned with one of the old-fashioned gold chains, always in boots with irreproachable blacking—such was Hilton's outer man as he sat upon one of the beds in his wards, examining an inflamed ulcer with a probe, that he might detect the exact position of the nerves exposed.

Hilton's claim to remembrance rests upon his essay *On the Influence of Mechanical and Physiological Rest in the Treatment of Accidents and Surgical Disease, and the Diagnostic Value of Pain.* The essay was delivered as a course of lectures at the Royal College of Surgeons of England in the years 1860, 1861, and 1862, and was published in 8vo form in 1863 ; the second edition, with the shortened title *On Rest and Pain*, was edited by Mr. W. H. A. Jacobson and published in 1877, the third in 1880, the fourth in 1887, and the fifth edition in 1892. All the editions except the first are in 12mo ; the third, fourth, and fifth contain no material changes. The book is interesting historically as showing the state of surgical practice in England when it was based entirely upon anatomy and was

JOHN HILTON

From a portrait in the library of the Royal College of Surgeons of England.

devoid of the assistance which it now receives from histology, bacteriology, and anæsthetics. It bears perhaps the same relation to modern surgery as *The Vestiges of Creation* bear to modern geology and biology. There is much morbid anatomy, with great common sense and some very crude speculation. It is a fascinating work, written by one who was master of one side of his subject but was unable to grasp the whole, partly because he was insufficiently acquainted with the advances made by his contemporaries, and partly because the means for developing the scientific aspects of surgery were not yet in existence.

The particular points upon which Hilton laid stress in his lectures were the blocking of the foramen of Magendie in some cases of internal hydrocephalus ; the opening of deep abscesses ; the referred pain in the knee in hip disease, and its anatomical explanation ; the cause of triple displacement in tuberculous disease of the knee ; and the importance of the early diagnosis and treatment of hip disease. All this, and many other things which are now the commonplaces of surgery, we owe to Hilton's book *On Rest and Pain*, in which the naive description of his cases and their treatment is by no means the least charming feature.

TRAUMATIC ANEURYSM OF THE RIGHT SUBCLAVIAN ARTERY TREATED BY LIGATURE OF THE FIRST PORTION OF THE SUBCLAVIAN TRUNK AND VERTEBRAL ARTERY.

By JAMES McCLURE, London.

I think the notes of a case of traumatic aneurysm of the subclavian artery, associated with a concurrent brachial monoplegia, which came under my care over three and a half years ago, are of sufficient interest to be placed on record. The patient has been under observation ever since, so that now the results of the operative treatment may be fairly regarded as reliable and permanent.

A. P., age 24, a discharged soldier, was admitted to the London Temperance Hospital on May 25, 1916. He complained of a painful swelling in the right side of his neck, of a constant ache in his right shoulder and chest, and of a burning pain along the inner side of the corresponding arm and forearm. Before he joined the army he had had no illness of any importance.

History of Present Condition.—At five o'clock in the morning of January 15, 1915, the patient was shot through the lower part of the right side of his neck by a "stray bullet from a machine-gun or sniper." He was standing erect in the act of transferring a small bag of potatoes from his right to the opposite shoulder when he was hit. His right arm "dropped powerless" and he fell to the ground unconscious. He remembered nothing more until about 5 p.m., when he spat some blood. This continued for a few hours and then stopped. There was no bleeding from the wound in the neck.

For four weeks he was unable to move his arm; but at the end of this time he recovered some use of the limb, though his fingers still remained "weak when using a knife and fork."

Two days after he was shot he reached the base hospital, and, three weeks later, "nearly three pints of blood were taken from the right side." To ease the pain he was in the habit of rubbing his shoulder and chest with his left hand, and on one such occasion he felt a lump above his collar-bone 'beating like a hammer.' It was then the size of a walnut. On the whole it has only increased to its present dimensions slowly, and indeed remained stationary for months at a time. He was discharged from the Army on June 2, 1915. Three days later he started work as a gateman on the tube railway, where he worked continuously as such up to the date of his admission to hospital in May, 1916.

Condition on Admission.—The scars of the entrance and exit wounds were situated at the junction of the inner and middle thirds of the clavicle close to its upper border, and about $1\frac{1}{4}$ inches below the middle of the spine of the scapula.

A tumour exceeding the size of a fœtal head occupied the whole of the posterior triangle of the neck, and extended inwards beneath the sternomastoid muscle, backwards and outwards under the trapezius to the scapula, and downwards beneath the clavicle, where its lower limit could not be determined. It appeared, however, to become continuous with an ill-defined mass which could be felt in the axilla and which pushed the pectoral muscle forward. The skin over it was tightly stretched, but there was no distention of the superficial veins, nor œdema or lividity in the arm or face. The main part of the swelling was round, fairly regular in outline, tense but resilient, and very tender to pressure posteriorly. The clavicle seemed to constrict and indent the swelling, as though a firm unyielding band had been tightly stretched across, dividing it into a larger supraclavicular and a smaller infraclavicular portion. The former pulsated visibly, and the pulsations

were expansile. A systolic bruit was audible over a limited area of the part above the clavicle. There was no thrill. The right brachial and forearm pulses could not be felt.

Motor Functions.—The right upper eyelid drooped, and narrowed the palpebral fissure, but the voluntary excursions of the eyelid were not at all diminished. The eyeball had definitely receded into the orbit, the right pupil was smaller than the left, and though contracting normally to light and to accommodation, it did not dilate as quickly as the left. There was no difference in sweating on the two sides of the head and neck, trunk, or arm. The ciliospinal reflex, tested by painful irritation of the skin of the neck, was present, and the pupil dilated after the instillation of a solution of cocaine.

With the exception of the thenar, hypothenar, and interossei muscles, which gave no response to faradic stimulation, the muscles of the upper extremity reacted to faradism, though not as briskly as the corresponding muscles of the opposite side. There was some

FIG. 382.—Skiagram taken on October 16, 1916, four months after operation. The absence of the inner end of the clavicle and atrophy of the first rib are clearly shown. There is an oval shadow indicating the outline of the sac, which extends into the upper part of the chest.

wasting of the supraspinatus muscle ; but any disability resulting from its paralysis was slight, for abduction of the humerus, though definitely weakened as compared with the left side, could still be performed by the deltoid. The intrinsic muscles of the hand were much wasted. When tested, these muscles exhibited the reaction of degeneration, and the typical *main en griffe* deformity was present.

Sensory Functions.—Although clinical data obtained by investigation of sensation were at times conflicting and uncertain, owing to the patient's restlessness and pain, it seemed pretty clear that there was an area anæsthetic to cotton-wool and pin-pricks over the front and back of the inner side of the arm and forearm as far as the wrist, corresponding to the cutaneous area subserved by the first thoracic posterior root.

The upper part of the right side of the chest was dull to percussion, and breath sounds and vocal resonance were absent over this area. No other abnormality was detected in his chest or abdomen.

X-ray Report.—Skiagrams of the right clavicular region showed great displacement of the clavicle and of the first two ribs, due to a large opaque body in the upper part of the right side of the thorax and neck. A traumatic aneurysm of the subclavian trunk was diagnosed, with injury to the first dorsal nerve.

Progress of the Case.—Absolute rest in bed was enjoined. The diet was dry, non-stimulating, and restricted. Calcium salts with large doses of potassium iodide were administered, while pain was relieved, but not abolished, by nepenthe and injections of morphia. Locally, ice-bags were applied as long as the patient would submit to their use. Instead of diminishing, however, the swelling slowly increased.

The deep gnawing pain in his chest and shoulder became almost unbearable. He was unable to sleep or rest, so that large and increasing doses of morphia were required to keep him quiet. The existence of severe and constant pain which was rapidly exhausting the

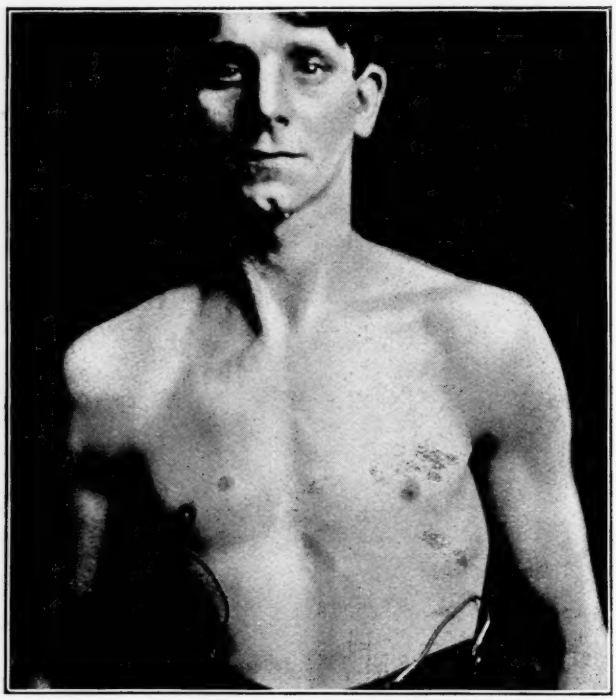

FIG. 383.—Taken Nov. 17, 1919. The present condition of the area of operation. The narrowing of the palpebral fissure is well shown, and the tenseness of the sternomastoid. The depression left after removal of the inner half of the clavicle is evident.

patient, and the increase in size of the swelling, which at no time showed any tendency to natural cure, were regarded as indications for operation. The possibilities of a sudden subcutaneous rupture, with death from syncope or gangrene of the limb, as the result of further treatment on expectant lines, as well as the risks of operation, were fully placed before the patient. He begged that something further might be done to relieve his suffering; and gave permission for disarticulation at the shoulder-joint should the necessity for this arise in the course of operative treatment. Having regard to the size and position of the tumour, extirpation or other local treatment of the sac was deemed too hazardous and therefore inadvisable; and for cure of the aneurysm it was decided to rely upon proximal ligature of the artery.

Operation.—On June 30, 1916, an incision was made along the anterior border of the sternomastoid muscle from the upper border of the thyroid cartilage to the level of the third rib, while another was carried inwards from the acromial end of the clavicle, one

inch below the lower border of the bone, to meet the first incision at the sternum. After reflection of this triangular flap of the superficial tissues, the clavicular head of the sterno-mastoid muscle, which was much attenuated, was carefully raised from the underlying parts and divided with scissors close to its attachment to the bone. It was not easy to recognize the usual landmarks at the root of the neck owing to the infiltration and condensation of the soft tissues around the tense aneurysmal swelling, which was found encroaching so much upon the limited space available for working on its inner side, that it was decided to resect the inner half of the clavicle. After removal of the bone, the outer border of the infrahyoid group of muscles was identified, and what was left of the sterno-hyoid was cut across. The finger now felt for the pulsations of the common carotid artery, which was exposed by traction inwards of the fibres of the sternothyroid muscle and by cutting through some areolar tissue in which were the distended tributaries running from the thyroid gland to the internal jugular vein. This structure, and the vagus, were held

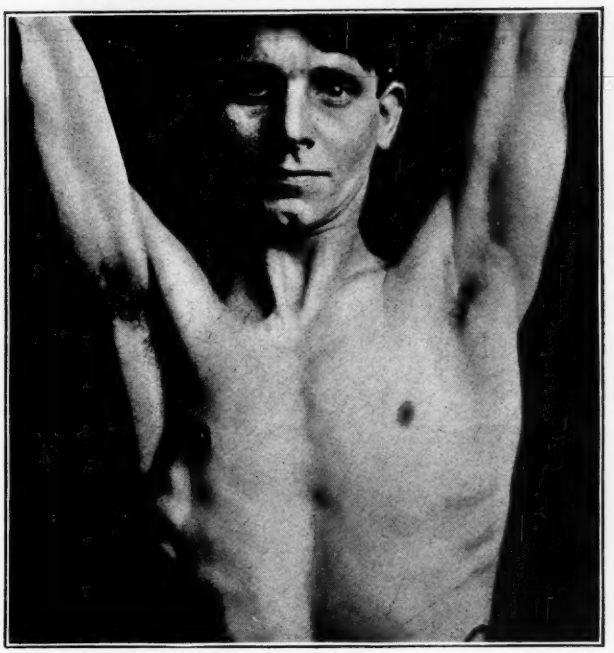

FIG. 384.—Shows that elevation of the arm can be carried out to nearly the same extent on each side.

outwards while the artery was traced downwards by blunt dissection as far as the innominate bifurcation. The subclavian trunk was found lying in a plane posterior to the carotid. It looked normal in size and structure. When it had been ascertained that occlusion of the vessel effectually controlled the circulation in the aneurysm, a stay-knot of soft floss silk was applied to the vessel close to its origin. No trouble was experienced in passing an ordinary aneurysm needle, unthreaded, from below upwards. Neither the recurrent laryngeal nor phrenic nerve was seen during this exposure of the artery, and the pleura was easily depressed and kept out of the way with the finger. Though all pulsation in the aneurysm had now completely stopped, it was decided to place a ligature on the vertebral artery, which was exposed as it came off from the posterior part of the parent trunk. By simultaneous ligature of the vertebral artery it was hoped to prevent the rapid establishment of a free collateral circulation. The wound was closed without drainage, a graduated pressure-dressing was applied to obliterate the dead space left as a result of the dissection, and the arm, enveloped in warm cotton-wool, was fixed to the side.

Subsequent Progress.—The stitches were removed on the tenth day, the wound having healed by first intention. Gradual solidification and diminution in size of the swelling took place, and when he left hospital on October 16 it had diminished to the size of a Tangerine orange. Its outline was nodular, and a cord-like band, movable from side to side, could be distinguished running downwards and outwards over its surface.

In December, 1919, there was no visible swelling, and, with the exception of the absence of the inner end of the clavicle, nothing abnormal could be felt in the neck.

Stereoscopic skiagrams taken at this time by Dr. Herbert Rhodes showed that the greater part of the opaque body in the upper portion of the thorax had disappeared, and that most of the first rib between its neck and costal cartilage had been eroded and destroyed by the pressure of the aneurysm.

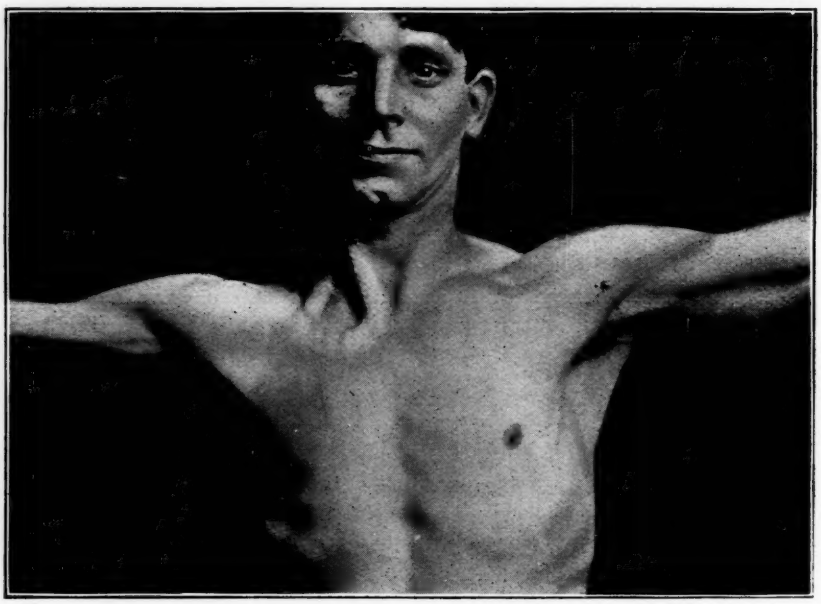

FIG. 385.—Abduction can be carried out to a right angle. The atrophy of the deltoid and upper arm muscles is evident.

COMMENTS.

It is interesting to note that whereas the brachial paralysis and hæmoptysis appeared very soon after he was wounded, the aneurysm was a comparatively late development. No swelling was observed in the track of the bullet, either by the man himself or by his attendants, for quite three weeks. Had any such tumour been present, it would almost certainly have been recognized, for the patient was at this time under constant supervision for a hæmothorax that was aspirated before he left the base hospital. The tumour was small, with no tendency to secondary extension, and, as active surgical measures were not undertaken, it may be presumed that the case was regarded in hospital as one likely to end in spontaneous consolidation and natural cure. He was therefore transferred to England. The swelling remained stationary in size, and, save for its pulsation, gave rise to no inconvenience until some months after he started work. Further escape of blood had been prevented by the firm hard coagulum. In course of time a traumatic aneurysm was formed with walls composed of organized blood-cot, supported externally by thickened and infiltrated tissues. During the period of reduced activities associated with enforced rest, its wall was strong enough to ensure limitation of the aneurysm, but it proved insufficient to prevent extension when the man resumed work that involved the free and constant use of both arms.

The damage produced by the bullet was not confined to the blood-vessel, for apparently all the functions subserved by the right brachial plexus were originally in abeyance. Thus the whole limb and shoulder girdle were paralyzed immediately following the receipt of the injury, and general wasting set in. Sensation was abolished, and there were evidences of interference with the right cervical sympathetic nerve. At the present time (December, 1919) it would appear that these functions as a whole are nearly restored. Although particular muscles, with the exception of the intrinsic hand group, are not noticeably weakened or wasted, there is relative diminution in power and bulk as compared with the left side, and this is accompanied by some impairment of faradic excitability. The weakness and wasting, however, are now passing off; but the flexor muscles of the wrist, deltoid, and latissimus dorsi are more affected than the middle-arm muscles; that is to say, the muscles supplied by the posterior and inner cords are slowest to recover. The wasting of the right supraspinatus muscle was due in all probability to a special lesion of the suprascapular nerve by the bullet towards its point of exit. Sensation is now normal over the inner side of the arm and forearm, but the oculopupillary phenomena of paralysis of the cervical sympathetic, that were noted on admission, still persist. The inequality of pupils, however, is not now so marked. The fibres concerned in these functions leave the ciliospinal centre and emerge from the cord chiefly by the first, but also by the second, thoracic root. As the ciliospinal reflex was present from the first in response to skin stimulation and cocaine, it is probable that some of the pupillodilator fibres from the second thoracic root had escaped injury in this case.

It may be inferred, therefore, that—apart from the general weakening of the brachial plexus as a result of concussion at first, and later of the pressure of effused blood—there has been a special lesion of the first thoracic nerve principally affecting its anterior root fibres, which are probably destroyed, but involving in some degree also the fibres of the posterior root.

Perhaps the most arresting feature of the case was the dramatic relief from great suffering and pain that followed the application of the ligature. No narcotics were given after operation, as the patient was able to rest and to sleep well without them. His general condition rapidly improved, and in January, 1917, he resumed his work as a gate-man on the electric railway, leaving this employment in June, 1918, to become a driver with charge of a horse-van in the service of a railway company. Six months ago he left the company, and, learning the trade of a cabinet-maker, he is now fully employed in this occupation.

Active movements at the shoulder-joint are normal. The absence of the inner half of the clavicle has in no way reduced his wage-earning capacity. Indeed, the loss of this bone in its entirety seems to be followed by no disability and to detract very little, if at all, from the functional utility of the limb. Thus, in 1918, I removed the whole of the left clavicle of a nurse for sarcoma. The patient still follows her usual vocation, and notices no difference in the power and usefulness of the arm. It would appear to be, therefore, both time-wasting and superfluous to replace any portion of the clavicle that may have been removed to facilitate subsequent operative procedures, while it is undeniable that, by reducing the time consumed in operating, the risks of wound infection will be correspondingly diminished.

I wish to express my thanks to Dr. Watts and Dr. Scarborough for their assistance throughout the operation; to Dr. Constable for much valuable help and care in supervising the daily records of the case; and to Mr. Howard Jones, whose skilful administration of ether by the intratracheal route contributed materially to the successful result.

THE SURGERY OF THE CHEST IN RELATION TO RETAINED PROJECTILES.

By Sir BERKELEY MOYNIHAN, Leeds.

(*Being the Hunterian Lecture delivered before the Royal College of Surgeons, on February 2, 1920.*)

What is the fate of patients who have received wounds of the chest, and who harbour a projectile within the thoracic cavity? There are doubtless many hundreds, it has even been asserted that there are thousands, of men now in England in whose lungs a projectile is retained. At the present time the evidence as to the discomforts or dangers to which they are prone is conflicting. It is conflicting because it is incomplete. On the one hand we hear that some few men, the bearers of a foreign body that is lodged in the lung or in the mediastinum, suffer very little; are almost forgetful of the fact that they have been wounded; and continue their civil work, sometimes perhaps very arduous, without suffering any disability which might lessen their value in the labour market. On the other hand we find that pensioners come, in small numbers it is true, to the civil hospitals, making complaints of the distress they experience, and asking for the removal of the projectile which they believe to be the cause of their suffering. In these latter cases it is neither the physical properties of the retained projectile, nor the presence of infection around it, which are alone to blame. For, of all the forms of projectile, a shrapnel ball or a rifle bullet might be supposed to be the least harmful. Their surfaces are smooth, and except at the point of a rifle bullet no injury is likely to be caused by the chafing of the projectile against the tissues on movement. Yet patients with these forms of foreign body seem to complain as much as do those in whose chests a sharp, jagged piece of metal is lodged. Nor is the degree of infection alone responsible, as is seen from the record of a case where a sterile rifle bullet was found embedded in lung tissue. Except for the greater likelihood of post-operative troubles, such as suppuration of the wound, or empyema, there does not appear to be any conspicuous clinical distinction to be made between those cases in which the foreign bodies are infected and those in which the projectile is sterile. And it is interesting to note that, although the lung is admittedly as capable of defending itself against microbic attack as any part of the body, an active infection may be found upon a projectile removed after three years' lodgement in the parenchyma.

Nor does the position of the foreign body in the lung afford any constant clue as to the cause of the symptoms of which complaint is made. It is true that if the foreign body lies in, or in contact with, the heart, the anxiety of the patient as to his future is increased. But whether a missile is lodged in one part of the lung or another does not seem to be of importance, so far as the existence or the severity of the chief symptoms is concerned.

The frequency, therefore, with which symptoms are present in the case of those harbouring projectiles in the chest is uncertain. So far as an inquiry is concerned which cannot pretend to statistical accuracy, it appears to be certain that the great majority of men make some complaint of subjective phenomena. So long ago as 1916, Denéchau, in an inquiry into the condition of fifty patients whose wounds dated back many months, elicited a history in every case of subjective disorders. In the times of active warfare we were all naturally and properly suspicious of purely subjective complaints. Scepticism

and incredulity were our defence against the blandishments and the special pleading of many an 'old soldier.' But the similarity of the symptoms in a long series of cases, where collusion is impossible, makes it unlikely that malingering alone is responsible. Exaggeration there may be, but similarity or identity of invention in many patients, at long intervals of time, and widely separated geographically, is unlikely. And it was not long, in my experience, before patients who had been discharged from the Army returned to hospital still complaining of their symptoms, and were willing, even eager, to submit to operation for their relief. So that if we discount fully the element of exaggeration, we are still confronted by a considerable body of evidence which goes to show that a projectile retained in the chest is a source of discomfort, variable in intensity, duration, and frequency, and of serious anxiety.

In my early experience I refrained from operating upon many patients, partly from ignorance of several matters concerned with intrathoracic surgery, and partly in the hope that delay in operating would allow of the firm encapsulation of the projectile, and the gradual recovery of the lung to a normal condition, or to a condition so nearly approaching the normal as to encourage the patient to return happily to full work. My advice to patients not to submit to operation was not always well received; and often I was urged to consider the removal of the projectile, as the patient was prepared to take the risk, though I had spoken of it in terms which now I realize were unduly grave.

In endeavouring to decide upon the principles which should govern us in the advice we give as to the removal of projectiles from the chest, we have to consider on the one hand the pathological conditions caused by the entrance of the projectile, the severity of the symptoms aroused, and the prospects of increasing or diminishing discomfort, disability, or danger from the continued lodgement of the foreign body or from the changes aroused at its rude entrance; and on the other hand the severity of the operation necessary for the removal of the missile, the mortality, the post-operative discomforts, and the results as expressed in the altered conditions in the chest, and in the consecutive changes in those symptoms for which the patient first sought relief.

Among the projectiles found in the chest cavity, fragments of shell are the commonest. They are usually of small size, rarely more than an inch in length; they have rough and pitted surfaces, jagged edges, and sharp points. In a small proportion of cases fragments of clothing are carried in with the metal, and are found lying with it in the chest. In most instances there is only one piece of metal. Machine-gun or rifle bullets are found, and shrapnel balls. On one occasion in a series of cases, a shrapnel ball was loose in the pleural cavity, in which it could be seen to roll about freely. It is very rare to find a large piece of metal in the chest: the probability is that all patients into whose chests such a foreign body penetrates, die as the early result of their injury.

I propose to consider the subject in the following order:—

A. Pathological changes caused by projectiles within the chest.
B. Symptoms to which they give rise.
C. Operations for the removal of projectiles.—General principles. Indications for operation. Operations: (1) Method of Petit de la Villéon; (2) Marion's method; (3) Duval's method; (4) Operations upon the root of the lung; (5) Operations upon the mediastinum.
D. After-history, and results of operations.
E. List of cases treated by operation.

A. PATHOLOGICAL CHANGES CAUSED BY PROJECTILES WITHIN THE CHEST.

1. **Wound of Entry.**—As a rule, the wound made by the projectile on entering the chest has healed. In the majority of the cases I have seen, the wound is in the chest wall (it may be in the neck or in the abdomen), sometimes on the side where the projectile has lodged, sometimes on the other side, a portion of the opposite pleural cavity and the mediastinum having been traversed before the missile comes to rest. It is very remark-

able to find that the mediastinum with all its contents may be pierced by a bullet or a fragment of shell, and yet the parts apparently suffer not the slightest injury. The supple and elastic vessels seem to yield place to the swiftly-moving metal; they certainly escape damage in a manner that sometimes appears incredible. In a few instances the bullet has passed through the arm into the chest; and in one case of mine some fragments of the humerus had been carried into the lung. The rib at the point of entry may be fractured, and minute fragments and splinters of the bone be swept inwards to the pleural cavity and the lung; a similar lesion may occur in the scapula or the sternum. It is the rule to find only one wound of entry, but, as in other parts of the body, the superficial lesions may be multiple, many fragments of splintered metal entering the chest wall, one or more of them passing through the parietes to lodge in the lung tissue.

The same conditions in respect of the missiles and their effects upon the soft parts are found in the chest as in the tissues of the limbs. The damage inflicted depends upon the size and shape of the projectile, its physical properties in respect of roughness and sharp edges, and its velocity. A rifle bullet discharged at a distance of 1500 yards, when its flight has become steady, may pass through the chest, cleaving its way, and leave behind very little evidence of trauma. A small fragment of coarse metal of ugly shape and lower velocity may bruise and tear and crush anything that lies in its path.

Wounds of the chest are often found in association with wounds elsewhere: in the abdomen, extremities, or head. Not only is the immediate problem of appropriate treatment affected thereby, but also the duration of convalescence and the quality of the ultimate recovery.

2. **The Path of the Projectile.**—So far as the soft parts are concerned, the lesions at once produced, and the conditions remaining after healing, are, as I have said, not different from those seen elsewhere. In the lung itself the course taken by a piece of metal can often be felt as a thick cord or strand when the lung is grasped in the hand. It is interesting that, in most instances, the foreign body is found near the surface of the lung; rarely in the middle of a lobe. It would seem that the central lung tissue itself offers very little resistance to the passage of a fragment of metal, which is brought to rest by the increased resistance it meets at the surface of a lobe. The projectile itself may be found at the very surface of the lung, embedded in adhesions of great thickness and density. In some instances it is not easy to say whether it has lain actually within the substance of the lung, or in masses of lymph deposited on the visceral pleura.

Two or three times, in separating the lung from the chest wall as gently as possible, I have felt the foreign body drop into my hand. The surface of the lung, when examined, merely showed a shallow pit with a rough and shaggy wall. In other instances the metal is frankly in the lung tissue, which has to be incised in order to release the foreign body. The lung may then show signs of 'hepatization,' being thick, hard, and red. Or in rare instances the metal may be surrounded by a very thick yellow fibrous capsule, within which are the remains of a small collection of dried pus.

In one case of mine, the tissue cut through resembled exactly the structure and consistence of a calcareous mesenteric gland, and for a moment I was inclined to think that the condition with which I was dealing was tuberculous. But as I cut deeper into the dense tissues I felt the metal against the knife, and a small fragment of shell-casing was released. Complete encapsulation of any foreign body is extremely rare. It is not often that a piece of clothing is found with the metal; when so found it is dark, deeply blood-stained, often offensive, and always infected. In two cases bronchiectasis was present, caused, no doubt, by the pressure of a fragment of metal of rather large size upon a large bronchus. In both cases expectoration before operation was profuse, and sometimes fœtid; in both there was local collapse of the lung, and in both the condition was seen on *x*-ray examination.

3. **Condition of the Pleural Surfaces.**—This varies within very wide limits. I have often been struck by the apparent discrepancy between the pathological conditions discovered in the chest at the time of operation, and the evidence of such conditions afforded by the ordinary methods of clinical examination. It is evident that percussion

and auscultation, even by the most expert physician, reveal only the coarser defects, and do not always discover even them. What appear to the surgeon to be gross changes may be quite unrecognizable on clinical investigation.

Adhesions of the two pleural surfaces are almost always present. They may be of the slightest and flimsiest texture, breaking down at the gentlest touch, and scattered thinly over a limited area. They may be of considerable density, and restricted to the line of flight of the foreign body. A thick anchorage of adhesions is then found, and the rest of the pleura may have few adhesions or none. In other instances the two pleural surfaces may have become so intimately adherent that it is possible to separate them only by the exercise of the greatest force short of roughness. Indeed, in some few instances I have been quite powerless to separate adhesions, and have had to divide them with knife and scissors ; even then their severance has been most difficult. In some instances the lymph poured out has become organized into the densest and heaviest felt-like material, which I have been able to dissect away in large sheets, and to keep as a specimen. Where adhesions are so very massive, they may isolate a small or large collection of fluid, old blood-clots, desiccated pus, or serum. Dense adhesions may be limited, only lying in the path of the projectile as I have just stated ; or they may cover the whole of one lobe, the other lobe or lobes being free ; or virtually the whole of the pleural surfaces may be involved. The lobes of the lung may adhere to each other. The lung may adhere along the inner side to the mediastinum, or to the pericardium. On the left side, especially, it may be difficult to say whether a foreign body which moves with the heart is in the edge of the lung, or on, or in, the pericardium ; for the parts adhere strongly and are not anatomically distinguishable one from another : a mass of fibrous tissue binds them all together. In several instances I have found very strong adhesions of the lung to the diaphragm, and the costodiaphragmatic angle has been filled with the organized remains of old blood-clot or of a pleural effusion. The immobility of the corresponding half of the diaphragm, as seen by *x*-ray examination, is easily understood in such cases.

4. **Infectivity of Projectiles.**—It was not always thought proper to examine the projectile bacteriologically ; this was done only in those cases where the metal was lifted directly out of its bed with sterile forceps, and held while a smear was taken from it. In all, eighteen projectiles were examined. In eleven there was infection by *Staphylococcus aureus*, streptococci, pneumococci, or coliform bacilli. In seven the foreign body was sterile.

B. SYMPTOMS PRESENT IN CASES WHERE A FOREIGN BODY IS RETAINED IN THE CHEST.

1. **Pain.**—This is present in the affected side of the chest. It is very variously described as 'soreness,' 'pricking,' 'stabbing,' 'burning.' It is fairly constant, but is increased when any exertion, work or play, is undertaken. More than one patient has told me that he felt then as though the side of the chest was being 'held in a clutch,' and that the pain was insupportable and brought with it a sense of acute anxiety and distress. The amount or the quality of the pain suffered does not often appear to have borne any very close relationship to the size of the projectile, to the extent or position of the wound or wounds of entry or exit, to the presence of operation wounds (indicating that an effort has been made to deal with the projectile, or with the injured lung), to a former empyema, to the restrictions in the movement of the diaphragm as discovered by *x* ray, or to the observed physical signs. It is certain that the pain is no worse in those cases where very extensive and extremely dense adhesions are present. In several of my cases the pleural cavity was quite obliterated, and the cohesion of the pleural surfaces was with the utmost difficulty undone. Yet patients so afflicted made no unusual complaint of pain.

Grey Turner has observed that pain and tenderness are especially noticeable in cases where a localized area of adhesions is found in the track of the missile—where, that is to say, a part only of the lung is firmly anchored to the pleura, the rest being free to move. A general diffuse adhesion, he says, between the pleural surfaces is not attended with pain, and indeed may be a means of preventing it. These observations agree with my own.

In my earlier cases I was a little at a loss to account for the pain of which so grievous complaints were sometimes made, and I was almost persuaded that the knowledge of the patient that a projectile was retained in the lung, together with a possible reluctance to be considered fit for duty in the line, might be held largely responsible for the manifold complaints. But this view was soon found to be untenable when pensioners, who were no longer faced with the possibilities of further service, who indeed had something to lose by being laid aside from work more remunerative than ever before, came to the hospital seeking relief. In them there was no need to estimate and to discount the coefficient of exaggeration.

By degrees it became certain that pain in all such cases was a real thing. In a large number of patients who have missiles retained anywhere in the chest there is a considerable degree of apprehension as to their future, a far greater degree, in my experience, than is found in men who have pieces of metal lodged elsewhere. I know no reason for this, but the fact is beyond doubt. In the years 1915 and 1916 I saw seven patients who did not appear to me to be suffering sufficiently to make it worth their while to submit to operation ; all were dissatisfied with my advice to have nothing done, and most of them came back finally for operation.

2. **Dyspnœa.**—This varies greatly in different cases. It may be felt only on severe or protracted exertion ; it may be slight even then. Or it may be an almost constant symptom, present when the patient is in repose, greatly augmented when he walks hurriedly, and especially on going upstairs or on climbing a hill with an eager pedestrian. There are times when pain and dyspnœa together produce a crisis of exhaustion, and the patient almost collapses in an agony of distress. I have twice seen patients in this condition when walking near the hospital. The dyspnœa on repose, and the effort dyspnœa, in all probability are both due to embarrassment of the lung crippled by adhesions, or to the massive remnants of an old hæmothorax, or to the shrinkage of the side of the chest and the mediastinal displacement and collapse of the lung which follow an empyema. There is not always a correspondence between the degree of distress and the amount of physical incapacity or deformity of the chest.

3. **Cough.**—This symptom is frequent as a rule, indeed in some degree constant ; though there are intervals in which it may be in abeyance, especially if the patient is kept in bed, or is bedridden by another lesion. Its presence is due not so much to the metal in the chest, as to such associated conditions as sinuses leading down to the pleural cavity or into the lung ; to infection around the foreign body, causing local hepatization of the lung, or abscess ; or to bronchiectasis or emphysema.

When an external sinus leads into the lung, its temporary closure may coincide with a period in which a teasing cough is accompanied by the copious expectoration of pus.

In a few cases *hæmoptysis* occurs. It is not often severe, but may be repeated on several occasions. It appears especially apt to follow on severe exertion. The first case in which I saw it, occurred in a man wounded in September, 1914 ; a large fragment of shell-casing was retained in the lower lobe of the right lung. The wound healed, and in April, 1915, he was returned as fit for duty. He was given bayonet practice, and a sharp hæmorrhage occurred at once ; a like experience followed on two occasions within a few days, and he then consulted the regimental medical officer.

I have seen three cases in which pain, dyspnœa, cough, purulent expectoration, and hæmoptysis have been present and have led to a diagnosis of pulmonary tuberculosis. Similar cases are recorded by Delmas and Fiolla. In one of my cases an *x*-ray diagnosis of a piece of metal retained in the lung was made, and an operation performed. No foreign body was found. The patient was subsequently stated to be suffering from phthisis.

The expectoration is sometimes abundant, frothy, purulent, and offensive. It appears, as a rule, within a week or two of the infliction of the injury, and it is rarely relieved by any treatment other than removal of the foreign body ; after that it disappears at once.

4. **Proneness to Chill.**—On making inquiry into the clinical history of patients in whose lung a foreign body is retained, I have been struck by their frequent reference to attacks of 'colds' or 'chills.' In these attacks, which last only a few days, the patient

feels cold, shivers, has 'goose flesh,' feels miserable, and keeps huddled over a fire. The dyspnœa and cough are a little worse, slight hæmoptysis may occur, and exertion is avoided. The temperature is raised for two or perhaps three evenings to 101° or 102°. The little attack soon passes off, and the patient feels himself again. These recurrent waves of infection—for that is what they are—show that the lung is not always tolerant of the presence of a septic foreign body.

5. **Palpitation.**—A number of patients have complained of severe palpitation, and of pain over the heart, as well as dyspnœa upon exertion; and several of them felt reluctant to lie upon the affected side. Irregularity of the pulse has never been noted, nor intermission.

In a very few cases there have been complaints of *digestive discomforts*, pain and flatulence after food, eructation chiefly due to air-swallowing, and constipation. In the worst of the cases there were many adhesions of the lung to the diaphragm.

C. OPERATIONS FOR THE REMOVAL OF PROJECTILES FROM THE CHEST.

GENERAL PRINCIPLES AND DETAILS.

The subject of thoracic surgery is one which, before the war, had been made difficult by the cumbersome methods employed. The fear of collapse of the lung when pneumothorax occurred was present in the minds of most surgeons, and was a powerful deterrent. The dread of pneumothorax was in truth the great inhibitory influence hindering the development of thoracic surgery. In the belief that it was necessary to prevent this, Sauerbruch and others in Germany, and Willy Meyer in New York, had devised and employed positive-pressure apparatus for anæsthesia, and negative-pressure chambers in which the trunk of the patient and the operation team were stationed during the whole of the procedures conducted upon an opened thorax.

There was, however, abundant evidence to show that the fear of pneumothorax was greatly exaggerated. For many years past I have been accustomed, in performing operations upon the kidney for stone or for removal of that organ, to begin by excising the last rib in order to obtain more room, and in order also to prevent undue dragging upon the pedicle of the kidney. In, possibly, a dozen of such cases I have wounded the pleura and have heard the air enter freely into the chest. No disability or distress followed, and I looked upon the misadventure as rather a flaw in the artistry of the operation than a matter of surgical importance, a rebuke to my skill rather than a risk to the patient. Similarly, in operating upon recurrent local growths in cases of carcinoma of the breast, I have removed portions of the chest wall and, by mishap or deliberate intention, have wounded the pleura. Again no harm followed. It is well known that Bazy, of Paris, had spoken of the safety of open operations on the chest for years before the war; and had derided the supposed difficulties or dangers following the free entry of air into the pleura, provided always that there was no myocardial disease.

All these experiences and opinions have been abundantly confirmed by the knowledge we now have of chest surgery in the late stages of gunshot wounds. The entry of air into the cavity of the pleura has produced one effect only, a temporary quiescence or cessation of the respirations. Before opening the pleura we have taken pains to obtain a deep anæsthesia. Air is allowed to enter the pleura slowly through an incision which, small at first, is subsequently freely enlarged, so as to allow of the easy entry of the hand into the chest cavity. The lung at once collapses, but the degree of collapse is, as a rule, slight compared with our expectations. It is not the degree of collapse seen in the post-mortem room. Such as it is, it is entirely to the advantage of the surgeon: it allows his manipulation to be more freely conducted within the chest; it enables him to reach all parts of the lung more easily; and it permits of the withdrawal of every part of the lung except the hilum from its ordinary position up to the anterior wound, and even outside the chest wall. I can imagine only one serious risk in the making of an open pneumothorax, and that is the wounding of the opposite pleura and the production of a double pneumo-

thorax. That has never occurred in any of my cases, and in operations upon the lung is, I suppose, an impossible catastrophe.

If, however, the œsophagus were being in part excised, the danger would be a real one and need to be kept in mind. Emboldened by my experience in these cases of gunshot wound of the chest, and on the urgent demand of a patient, I recently excised a growth including 3 in. of the œsophagus. The growth lay below the arch of the aorta, to which, and to the posterior surface of the left auricle, it was firmly adherent. I excised the 7th left rib and divided the 6th, 5th, 4th, and 3rd ribs posteriorly, and, introducing Balfour's abdominal retractor, spread the ribs apart very widely. I laid the pleural cavity open freely and obtained a wonderful view of the heart, aorta, great vessels arising from it, trachea, œsophagus, and lung. The actual operation for removal was then made very easy; but remembering that the relations of the œsophagus in that region are more intimate with the right pleura than with the left, the most scrupulous care was taken to avoid any opening of the opposite pleural cavity.

The Separation of the Pleural Adhesions.—The number, density, and strength of the adhesions found in the pleural cavity vary within the widest limits. They may be few, thin, and light, separating at the gentle touch of the finger; or they may be of the utmost density. I have several times had to dissect off from the surface of the lung thick masses of lymph, as solid as the felt of which a flat-foot pad is made. In such a case it is interesting to see the lung expanding little by little as it is freed from the dense adhesion which has clearly been compressing it.

In my earlier cases I felt that the indication for operation was the presence of the foreign body in the lung, and that the removal of that foreign body was the sole purpose of the operation to be performed. By degrees I came to believe that the removal of the projectile was only a part, and perhaps not always the most important part, of the operation. The adhesions encountered were so considerable in many instances, that I became persuaded their presence alone would account for most of the disabilities of which the patient complained, and that their separation or removal would alone give relief to all distress. But realizing the frequency of infection present on the foreign body and the occasional presence of fragments of clothing which were always very offensive, I concluded that the purpose of the operation was a dual one, and that there was perhaps little to choose between the relative importance of the two intentions.

The separation of dense adhesions following perhaps upon a hæmothorax or upon an empyema is by no means free from serious consequences, especially if the foreign body which at last is reached and removed, is infected. In five of my cases empyema followed such a procedure: in all the foreign body was infected, in all there was hæmorrhage into the pleural cavity after the operation, and aspiration of this was in the first place necessary. The lesson to be learnt from this experience is that, in all cases requiring the removal of dense adhesions, the greatest care should be taken to secure perfect hæmostasis before the chest is closed. We have only a slight experience of draining such cases for one or two days, but such as it is it suggests that, where oozing cannot be completely checked at the time of operation, drainage gives safety and comfort. The continuance of the tube for longer than, say, thirty-six hours is probably harmful. Our general practice has been firmly and continually opposed to drainage wherever possible.

The dual intention of the operation is shown also by a consideration of those cases in which the projectile has passed completely through the thorax, or has passed through the pleural cavity and lies embedded in the chest wall. In such cases a high degree of respiratory embarrassment, due to pleural adhesions the result of an old hæmothorax, may be present. The opening of the chest cavity to free the lung from the thick membranes which cripple its action is then certainly desirable, though no foreign body require to be removed.

Anæsthesia.—The question of the anæsthetic to be used required, of course, very anxious consideration. We considered first the possibility of performing all the operations under local infiltrative anæsthesia, or under the paravertebral regional anæsthesia which I have seen used so successfully by Pauchet, of Amiens. Chloroform here,

as elsewhere, I refused to sanction. The obvious dangers are great, and its remote dangers in all cases not yet sufficiently realized. For years I have abandoned its use, and I saw no reason to try it in cases of this kind.

Ether has proved so satisfactory in all my work that I determined, if possible, to retain it here also, with or without gas, and oxygen-ether is universally applicable. Dr. Adamson has acted as anæsthetist at every operation, and she has kindly written the following brief account of her method and experience.

Method of Anæsthesia for Intrathoracic Operations.—The method of obtaining a satisfactory anæsthesia for intrathoracic operations involved very little difficulty after the first three or four cases. The first cases were frankly experimental from the point of view both of the depth of anæsthesia required and of the means by which this might be brought about. The method has now been stereotyped in its essential points, and only calls for variations to meet minor differences in individual patients: the patients have all been young men from 19 to 34 years, in sound condition resulting from military training, and immediately before operation have been free from any infection giving rise to a high temperature. Many of them have required a large amount of anæsthetic.

The anæsthetic used for all the cases has been ether, administered through a Hewitt's wide-bore apparatus. This has been chosen for the following reasons: the ether has acted to a certain extent as a respiratory stimulant in cases which have had to carry on their whole respiratory function with one lung only; and for the convenience of the operator the depth of the anæsthesia has needed to be so great that chloroform administered to such a degree would have been extremely dangerous.

Having chosen ether as the more suitable anæsthetic, and considering it unwise to give any chloroform at all, it is obviously impossible, with this class of patient, to induce a satisfactory anæsthesia by the open method. The closed inhaler has been used throughout the series of cases. A positive-pressure apparatus was not used, as the surgeon wished for a collapsed lung.

In the earlier cases nitrous oxide gas was used to begin the induction, but has been discontinued because of a tendency to persistent cyanosis which appeared in some of the patients who were already the subjects of varying degrees of dyspnœa.

Before coming to the theatre the patients are given a preliminary hypodermic injection of morphine gr. $\frac{1}{6}$, scopolamine gr. $\frac{1}{150}$, and atropine gr. $\frac{1}{100}$, half an hour before the induction of general anæsthesia. This preliminary injection overcomes the agitation some of the patients show at the prospect of what is to them an alarming operation, and it also overcomes any trouble from excessive salivary or bronchial secretions.

Induction is begun with the Hewitt's apparatus without the bag, the proportion of ether being increased from nothing to the full strength possible. When this point is reached, and when the patient is breathing easily, the bag is fixed to the apparatus and used until the completion of the operation. For most patients the anæsthesia produced by this method alone is insufficient, and then the strength of ether vapour is increased by placing the bag in a bowl of hot water and also by surrounding the ether container with a swab wrung out of hot water. With this added help it has practically always been possible to obtain the required depth of anæsthesia, however powerful and resistant the patient, provided this has been carried out before the pleural cavity is opened.

From the outset, anæsthesia is pushed to a considerable depth, allowing of complete muscular relaxation, and for a few minutes before the pleural cavity is opened the end of a flexible rubber tube connected with an oxygen cylinder is introduced under the edge of the face-piece of the inhaler and a gentle stream of oxygen allowed to pass along it. The face-piece is then kept slightly tilted to prevent over-distention of the bag with oxygen, but it is not removed periodically to give the patient a breath of fresh air as is usual when employing a closed inhaler for other operations.

At the time of the incision of the pleura the patient is deeply anæsthetized, breathing evenly and slowly, and his colour is bright red from the inhalation of an excess of oxygen. Directly the pleural cavity is opened, the lung, if free from adhesions, collapses, and the patient stops breathing. The period of apnœa varies from a few seconds to one or two minutes. The pulse remains regular, and usually unchanged in rate. In a few cases the rate has been increased by ten to twenty beats a minute for a few minutes and has then returned to its previous rate. The patient's colour has remained bright red.

Breathing recommences at about the previous rate, but the range of respiration is

extremely shallow, and remains so until the end of the operation. For this reason it is essential that the opening of the pleural cavity shall be delayed until a satisfactory deep anæsthesia is obtained, as it has been found quite impossible to repair the omission later. The stream of oxygen is continued during the whole operation, and may need to be slightly increased for a short time after the resumption of respiration following the period of apnœa. The anæsthesia produced in this way is sufficient to allow of the necessary manipulation of the lung and freeing of adhesions, the delivery of the lung through the wound to allow of thorough examination, and the stitching of any bleeding wound in the lung or its root. In cases which have involved manipulation of the heart there has been a temporary weakening of the pulse corresponding to any definite pressure on the heart. There has been no irregularity or missing of heart-beats noticed from this cause.

At the end of the operation the patient's colour is usually bright red, the respirations are still shallow and regular, and the pulse is of the quality that it was at the beginning. In most cases the administration of oxygen has been stopped directly the pleural cavity has been closed, and the patient has remained comfortable and of good colour on his return to bed. In a few cases the respirations have been too shallow to maintain a satisfactory oxygenation of the blood, and the patient has become markedly cyanosed and his pulse has begun to fail. This unsatisfactory condition has been remedied by administering small quantities of oxygen at intervals, whenever the patient's colour becomes in the least blue.

The only real difficulty in connection with the anæsthesia for intrathoracic operations is in obtaining a sufficient depth in the patients who require a large amount of anæsthetic to produce even unconsciousness. If the patient is insufficiently anæsthetized he is the subject of a most troublesome cough and straining each time an attempt is made to touch the lung. This greatly hampers the operation, and, owing to the shallow respiration and consequent small amount of anæsthetic inhaled when the pleural cavity is opened, it is practically impossible to deepen the anæsthesia at this stage.

On this account it should be emphasized that it is essential to secure a complete anæsthesia without cyanosis before the pleural cavity is opened, even if it leads to apparent delay in the operation.

The Use of X Rays during Operation.—The performance of operations for the removal of foreign bodies, in all parts of the body, under the *x* rays has been almost universally practised in France, where special operation tables have been devised, and where the radioscopic 'bonnet' has been perfected. Comparatively little use has been made in the British Army of such methods. Various criticisms of an *a priori* kind have been brought against the French methods. It is said that the operator does not know where his instrument is going when it is pushed directly through the tissues of the limb or the chest, from the surface to the foreign body; that vessels or nerves may be encountered unwittingly and seriously damaged, with grave consequences; that the foreign body, even when reached, may not be easily grasped; and that the forcible and rough withdrawal of a foreign body, perhaps heavily infected, through sound tissues may be the cause of an acute recrudescence of sepsis in the wound. It is said that such operations are 'groping in the dark,' and that a method is 'unsurgical' which does not allow the operator to see what he is doing and where he is going. I confess that I felt a certain sympathy with all these objections; but they are, I now realize, quite invalid. The success, not of a few cases but of many thousands, has shown, I think indisputably, that the screen methods are, on the whole, and in properly chosen cases, safer than the open methods, and that their after-consequences are at least as tranquil. To the criticism that the operations are 'blind', the expert French surgeon replies that, on the contrary, under the screen he sees exactly what he is doing, and that, when the foreign body has been accurately localized, he knows precisely what structure he may meet, and what structure he must avoid. And he will point to a very long series of cases to show that the fear of infection of the track along which the metal is withdrawn is excessively small. It is admitted, of course, that the methods have not a universal application. There are regions, like the heart or the hilum of the lung, that must always be approached by the open method. And there are projectiles so large that they cannot be withdrawn from the chest in the narrow space between two ribs. The work needs a special brief education;

but the fact that the technique is by no means especially difficult is shown by its wide adoption by the army surgeons in France, and by the success which has attended it in all hands.

Whatever operation is practised upon the chest, the most accurate localization of the foreign body by *x* rays is desirable; and the condition of the lung, the presence of pleural adhesions, and the range of movement in the diaphragm, should all be investigated. My colleague, Dr. H. B. Scargill, who has conducted all the radiological examinations in my cases, has kindly written the following brief note.

RADIOLOGICAL EXAMINATION.—This resolves itself into three parts:—

1. *The Localization of the Foreign Body should be as Accurate as possible.*—It is advisable to mark the position of the foreign body on both anterior and posterior surfaces, and to indicate the distance of the foreign body from each.

The radiograph should always be taken from the surface nearer to the foreign body. The depth from the surface can be ascertained by any of the usual methods. It is advisable to make observations from the anterior and posterior surfaces as a means of checking the result obtained.

2. *The Screen Examination of the Chest.*—If the metal moves downwards on deep inspiration, it must be in the lung, or embedded in the diaphragm.

If in the root of the lung the movement is downward, but is very slight indeed.

If the movement is upward on inspiration, the metal is either (*a*) in the chest wall, or (*b*) in a portion of the lung which is firmly adherent to the chest wall and can only move with the chest wall.

3. *The Examination for Adhesions of the Lung and Chest Wall.*—In the lower part of the chest, the movement of the arch of the diaphragm on the affected side is most important as an indication of the degree of expansion of the lung.

Around a part of the lung which is adherent to the chest wall there is generally patchy opacity to be seen, due to thickening of the pleura. In some cases the lung and pleura may appear quite translucent, and yet at operation there may be found very firm adhesions.

Adhesions can only be seen as opacities when there is thickening of the pleura of long standing.

INDICATIONS FOR OPERATION.

So far as our present knowledge goes, the indications for operation seem to be:—

1. *The Continued Presence of Subjective Symptoms.*—A full account of these, as seen in my own cases, has been already given. In all the cases I have dealt with by operation the complaints have been real, and the distress, in the patient's opinion, has been ample warrant for his submission to an operation, the perils of which I did nothing to belittle. It must be admitted that in many patients a degree of apprehension with regard to their condition exists, and that consequently their subjective phenomena may lack nothing in descriptive detail. But an increasing experience has shown that the *x*-ray disclosures and the conditions found at operation often account fully for the presence of symptoms which had been ascribed to 'functional' causes. The presence of thick masses of adhesions, which revealed little or no evidence on auscultation or percussion—especially adhesions to the diaphragm—will account for many legitimate complaints of pain in the mediastinal regions, or in the abdomen. It is not so much the mere presence of a foreign body in the lung that should be considered, but rather the various changes in the lung and in the pleura which result from the original injury, and which are chiefly the cause of symptoms and chiefly in need of relief.

2. *The Conditions of the Foreign Body and of the Lung Surrounding it.*—The foreign body induces certain changes in the parts of the lung in its immediate neighbourhood. These are described elsewhere. A complete investment of the foreign body by a fibrous covering is rare. Only once have I seen a piece of metal so closely covered on all sides as to be isolated from lung tissue and, so far as could be judged, incapable of inflicting further injury on the parenchyma. Conditions which are those of perfect and permanent tolerance of a foreign body are, therefore, extremely rare. Around the foreign body the

physical conditions of the lung, however altered, are rendered more, rather than less, likely to be made active by the presence of an irritating or infected piece of metal, or of clothing. If we take into account the character of the foreign bodies retained, the physical properties of the tissue in which they are held, the incessant movement of the chest, the high degree of physiological activity present in the lung, and the number and size of the vessels in the chest and in the lung tissue, it is probably, as a rule, wiser to advise removal of the foreign body than to sanction its retention.

3. *The Conditions of the Pleural Cavity.*—In many cases that I have operated upon, pleural adhesions were present in a degree that alone would cause a restriction of the activities of the lung. In such cases the measurements of the chest on the affected side are smaller ; dullness may be present in some degree ; and there is deficient entry of air into the chest. The sinking in of the chest wall, the collapse of the lung, and the pulling over of the whole mediastinum, are results of the pleural injury and the pathological conditions subsequently developed and are causes of the respiratory and other difficulties of which an account is given elsewhere.

It is important to know to what extent these conditions can be relieved by operation. Speaking broadly, two types of operations are performed in such cases—the method of Petit de la Villéon, and the open method. In the former, nothing is done to alter the physical conditions within the chest cavity other than the removal of the foreign body. In the latter, all adhesions are separated, masses of lymph dissected off the lung and the diaphragm, and a considerable attempt made to cause a return of the conditions to the normal. How far such efforts are successful is, with the evidence at my disposal, a matter of doubt. If there has been an empyema before the operation, I think the conditions in my own cases have not been improved. This may possibly be due to a too early operation in which infection has been freshly aroused, here as elsewhere, by precocious interference. If adhesions have been extensive and dense, their removal has certainly given increased freedom to the action of the lung. The records of my cases show that benefit has almost always resulted in such cases. Improvement does not occur in the same degree or so rapidly if no operation is done ; for in patients whom I have kept under observation for months before operation, the change in the condition of the chest on examination, clinically or by *x* rays, and the improvement in their subjective disturbances, has been either absent or exceedingly small. Open operation may therefore be said to be justified by its results.

METHODS OF OPERATION.

The methods which have been practised for the removal of foreign bodies from the chest will be considered in the following order : (1) *Method of Petit de la Villéon ;* (2) *Method of Marion ;* (3) *The open method of Duval ;* (4) *Operations upon the hilum of the lung ;* (5) *Operations upon the mediastinum.*

1. **Method of Dr. Petit de la Villéon.**—The operation consists in the introduction, through a very small incision made between two ribs, of a special pair of forceps, with a blunt end and long parallel blades on the one side of the hinge, and short 'crocodile-jaw' blades on the other. The position of the foreign body is very accurately determined by the *x* ray. The operation is performed under the *x* ray and with the aid of the screen. A preliminary injection of morphine is given and a light general anæsthesia induced. Petit de la Villéon uses chloroform. The forceps are introduced from the axillary side, the incision to admit them being made along the upper border of the rib, so as to avoid vessels, and are guided by the image on the screen and directed towards the known position of the foreign body. The progress of the instrument is slow and gentle, and continues until the image of the tip of the forceps and of the foreign body coincide. If the entry has been expertly made the contact will then be felt ; the metal is grasped by the wide opening of the 'crocodile-jaw' blades, and is slowly and steadily withdrawn. Nothing remains but to close the skin wound by a single stitch. The penetration of a blunt forceps into the lung tissue does no damage. It ruptures no vessels ; it does no

injury to the delicate tissues of the lung; it seems to cause a separation of the tissues rather than a destruction of them. The experience of recent wounds of the lungs in this war has shown how very tolerant of injury they are, and how few are the symptoms produced by the slighter degrees of trauma. It is not then surprising to hear that a blunt instrument may be gently pushed through the lung substance without giving rise to any real danger. The withdrawal of a foreign body might be attended by more serious injury, especially if there were many sharp points and rough surfaces; these, however, do not inflict much injury, if any, if the jaws of the forceps grasp and include the foreign body in their embrace. Such damage as is caused would be enhanced in severity if the metal chanced to be infected by one or more organisms, which we know will remain potentially active in the lung for years. But suppositions and fear must yield to experience; and this has given abundant proof, in the hands of all, that the risks of injury are almost negligible. The mortality has been found to be extremely small, far less than by any other operation practised. The post-operative course is so smooth and devoid of incident as to excite the frank astonishment of all who see the method practised for the first time. The functional recovery is said to be at least as good as that which follows the open operations; and is obtained at less risk and less cost in respect of suffering and duration of convalescence.

There are certain contra-indications to the method :—

a. Proximity of the Foreign Body to the Hilum of the Lung.—One of the few fatalities in the large series of cases operated upon by Petit de la Villéon occurred as the result of hæmorrhage after extraction of a piece of metal from the hilum. He, and every other surgeon, now agrees that for all retained projectiles in this position an open operation is necessary. It is imperative that the work to be done should be carried out under open inspection, and that steps should be taken to avoid laceration of the large and numerous vessels in the root of the lung, and to arrest such hæmorrhage as occurs either by suture or, as Petit de la Villéon prefers, by packing with gauze for two or three days.

b. Proximity of the Foreign Body to the Heart.—In one of his cases reported in *Bull. et Mém. Soc. de Chir. de Paris*, 1918, p. 577, Petit de la Villéon describes the projectile as "appearing to be included in the wall of the left ventricle of the heart." It was extracted by his method, the forceps passing through the entire thickness of the lower lobe of the left lung. In another case some fibres of heart muscle were found on the missile after removal. In his most skilful hands the method does not appear to have presented unusual difficulties or serious dangers; but it is nevertheless one to be condemned. In all cases where the projectile is adherent to the surface of the heart, or in which the lung is so adherent to the pericardium, and this membrane to the heart, that it is impossible to say how close the connection between the missile and the heart may be, the open operation alone should be practised.

c. The Size of the Projectile.—The great majority of the foreign bodies lodged in the parenchyma of the lung are of so small a size as to allow of their easy extraction between the ribs. If the projectile is large, a piece of rib may be resected, or raised, and the remainder of the operation conducted in the usual manner. But even then the damage done to the lung by the forcible dragging through its tissues of a large solid body must be taken seriously into account. For large projectiles the open operation is either the only possible method, or the safer.

d. Suppuration Round the Projectile.—This can generally be determined by the radiologist. When it is evident that a small abscess surrounds the foreign body, or that it is encased in a hard sclerotic mass, it is unwise to attempt the removal by this method. It is impossible to say whether the pus which lies on all sides of the missile is heavily infected or no. But it is well to take no risks. The removal of the foreign body in all such cases should be done under full inspection, so that an adequate cleansing of the infected cavity may be secured.

e. The Presence of Other Foreign Bodies than that shown on the Screen.—It is not often that pieces of clothing are found with the projectiles in the parenchyma of the lung. I know no explanation for this: but it is, in my experience, far less frequent to find débris

of clothing in the lung than in the limbs, when pieces of metal are being removed. The danger of leaving behind a piece of cloth is therefore very slight, and the subsequent clinical history of a large number of cases shows that the risk is one that need hardly be considered. Petit de la Villéon believes that in many cases he removes not only the foreign body but its capsule, and any other foreign body included in it. Such an experience must, I am sure, be exceedingly infrequent.

The essential circumstance for the successful extraction of the projectile by this method is its *mobility with the lung*. This is indicated by the *x* ray; the shadow of the foreign body should move downwards concomitantly with the diaphragm. The exception is in the case of foreign bodies in the apex of the lung, where the range of movement is slight or absent. This freedom of motion indicates that the metal is not embedded in a mass of dense adhesions outside the lung, extrication from which would involve gross and heavy-handed measures. The benignity of the operation is remarkable. It is rare for a patient to be incapable of discharge from hospital in eight or ten days.

It has often been asserted that the method is a 'blind' one; that the surgeon is 'groping in the dark'; and that it is easy to lose one's way and to be compelled to pierce the lung in several directions until contact with the metallic foreign body is made. All these things depend upon the surgeon. To render it not a 'blind' but an open method —a 'clairvoyant method'—it is necessary for the operator to become practised in screen examinations, and to make himself an adept in the removal of projectiles from the limbs. As Petit de la Villéon says, an apprenticeship is necessary. This is hardly an objection, or if it is, it has a wide application. The method has on many occasions been controlled in this way: the small external incision has been made, the lung pierced, the forceps left *in situ*, and the chest opened to remove a foreign body whose fibrous casing has been dense, or whose situation in the diaphragm has made withdrawal difficult. An inspection of the lung has shown only a slight bruise at the point of entry of the forceps, and 'not a drop' of blood has been seen to issue from the path made in the lung.

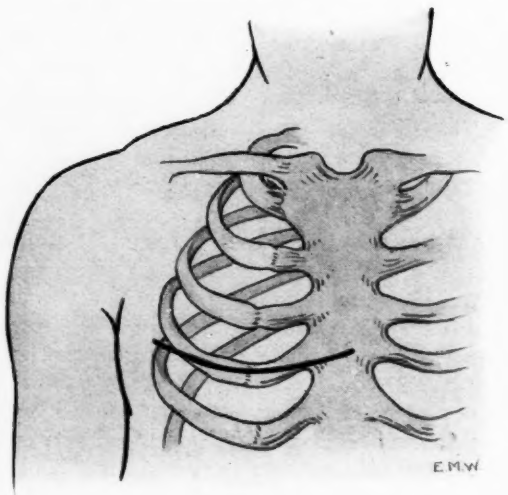

FIG. 386.—The skin incision follows the line of the 4th rib.

There are times when a little air escapes into the pleural cavity by the side of the forceps. This is of no account. We know by long experience how little is the harm done by a pneumothorax so caused, as, for example, in operation on the kidney when the last rib is removed. Robineau, indeed, holds the opinion that it may even make the operation easier. He finds also that when the method is practised as an open operation, in the circumstances just mentioned, the movement of the forceps within the lung is always free, causes no hæmorrhage, never lacerates the lung, but allows it to slip forwards and backwards along the forceps with great ease.

The most alarming consequence which has followed upon this method is hæmoptysis. In some degree this occurs in the majority of cases; in serious, degree very seldom. Margins records one case in which the hæmorrhage was extremely serious though not fatal.

An occasional rise of temperature occurs; and a localized patch of consolidation may be found. In one case P. Duval lost a patient from double pneumonia. A serous effusion of slight degree into the pleural cavity is not infrequent. The evidences of it usually disappear within four or five days.

2. **Marion's Method.**—This consists in resection of one rib in front, usually the 4th

or 5th. When the pleura is exposed and the lung is visible underneath, a curved Reverdin needle is passed through the pleura into the lung, out through the pleura again, and the stitch tied. A series of such stitches fix the lung firmly to the parietal pleura. When such fixation is thought to be complete, the pleura and lung together are incised. Air does not enter the pleural cavity ; that is to say, no pneumothorax develops. From the incised lung, air and blood escape. A finger is pushed into the wound, and the foreign body felt and extracted with the finger ; or a Kocher's forceps, or other instrument, is passed into the lung until the foreign body is felt, seized, and then extracted. Marion then passes a strip of gauze into the wound in the lung and allows this to remain for a few days. The parietal wound is closed round the gauze.

I can see little advantage in this method. The fear of pneumothorax is an exaggerated fear. The one reason for its adoption may be this, that in cases of infected foreign bodies the risk of conveyance of the infection is limited to the small track through the lung and to the parietal wound : it does not affect the cavity of the pleura.

The objection has been brought against the method that it creates a solid mass of adhesions fixing the lung to the parietal pleura. That is true : but some degree of adhesion of the lung no doubt occurs to every parietal wound in the ordinary open operation, especially when the pleural coaptation has been imperfect, as it often is. Some surgeons, R. Oliver, of Lyon, for example, speak enthusiastically of this method. (*Lyon Chir.*, 1918, xv, 351.)

3. **The Open Operation of Duval.**—The operation I have performed in my cases—a slight modification of Duval's—is the following : An incision is made exactly in the line of a rib (*Fig.* 386), following its curve, from the edge of the sternum outwards, for about 5 inches. As a rule the 4th rib is chosen. If the projectile is in the apex of the lung the 3rd rib may guide the line of incision ; if the projectile is at the lower part of the chest the 5th rib is selected. The room given for the introduction of the hand is greater, the lower the incision is made. The incision cuts through the skin, subcutaneous tissue, and pectoralis fascia, and exposes the fibres of the pectoralis major muscle. A pair of forceps is pushed through the fibres of the muscle until it touches the rib ; the blades are opened and the muscle is split, and the separation is widely made from end to end of the original incision. The pectoralis minor is then exposed, and may be split in the same manner, or cut away until the outer surface of the rib is seen. All vessels which bleed, and there are many, are carefully ligatured : for a very dry wound is essential.

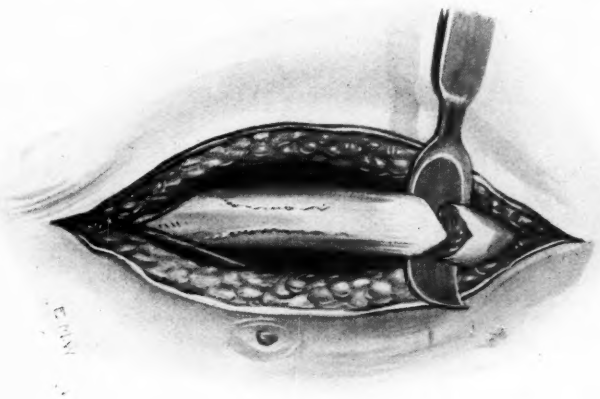

FIG. 387.—Division of the costal cartilage

The rib and costal cartilage are now well exposed. Through the periosteum two incisions are made close to the upper and lower edges of the rib, and from them the periosteum is stripped upwards and downwards and from the posterior surface. The periosteum which lies between the two incisions is not separated from the rib, but remains attached to it through all the stages of the operation.

As soon as the periosteum is freed from the posterior surface for half an inch, the periosteal elevator of Doyen is slipped round the rib, and pushed backwards towards the axilla and forwards to and along the costal cartilage, until a length of about 5 inches is cleared. Here and there a little help may be needed with the knife or scissors to make the way easy for the instrument. The costal cartilage is now divided by

two incisions meeting at a point (*Fig.* 387); this allows the divided ends to dovetail together when the operation is nearing completion. When the cartilage is divided, a gauze strip is passed underneath the rib, which is lifted gently upwards and outwards (*Fig.* 388).

In young patients the elasticity and suppleness of the rib are remarkable. It is quite easy to raise the bone out of the way throughout the operation and then to replace it. The third rib does not lift so easily as the lower ribs, being shorter and therefore more resistant. In four cases (three of the 3rd rib) the bone has fractured as the result of the drag made on it. In three cases it was replaced and united firmly. When the rib is elevated, the periosteum is seen as a thickening of the pleura exposed in the wound.

Through periosteum and pleura a small incision is made, with the result that, in the absence of adhesions, air slowly enters the pleural cavity, and the lung begins

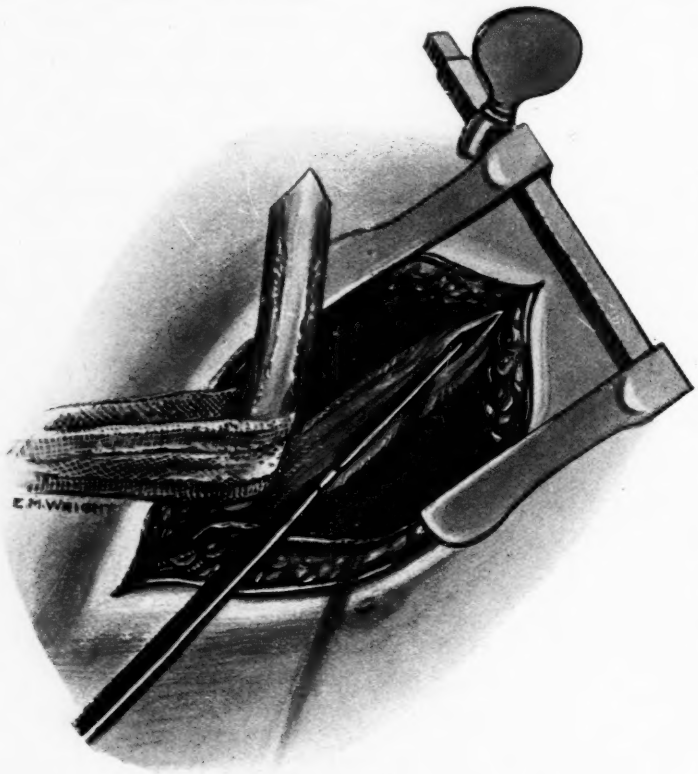

FIG. 388.—Tuffier's rib-retractor introduced separates 3rd from 5th rib widely. Incision of periosteum and pleura. The rib is lifted out of the way: as a rule it is raised higher than is here shown.

to collapse. It is, I think, important to allow of the slow development of the pneumothorax; a sudden collapse of the lung might cause a little respiratory embarrassment. If air enters very slowly, the regular breathing is hardly disturbed for more than a few seconds or a minute, and the operation can proceed as tranquilly, so far as anæsthesia is concerned, as if it involved one of the extremities. Le Fort is, I believe, alone in saying that an immediate wide opening of the pleura is safer than the practice of making a small incision and allowing air to enter

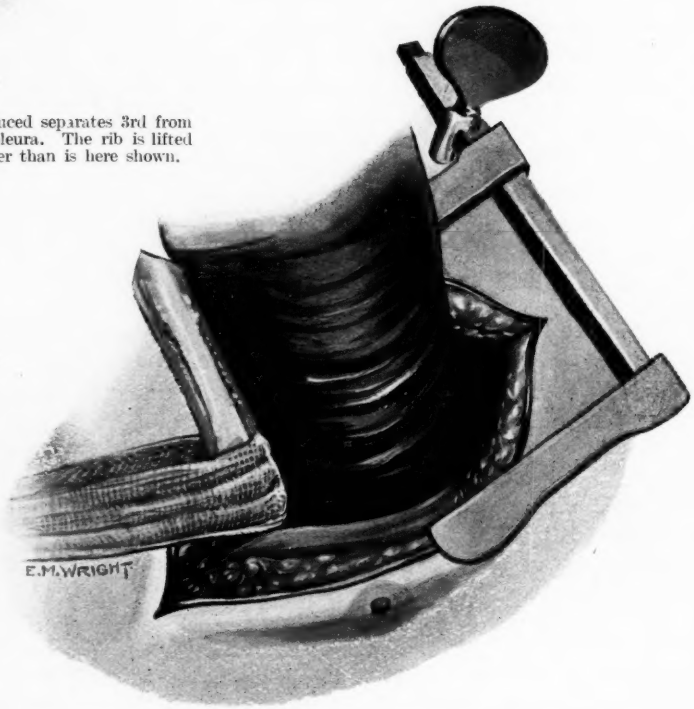

FIG. 389.—The hand introduced into the pleura to separate adhesions, etc.

slowly. The incision in the pleura is then lengthened, always along the line of the periosteum, until there is room for the hand to pass through it. The rib-spreader is then introduced (*Figs.* 388, 389). Tuffier's pattern is the most easily worked, and is very helpful. Separation of the ribs above and below that which has been elevated is always easy enough. I have never found it necessary to remove or elevate another rib, or to divide another costal cartilage to allow of more space being obtained by further displacement of the ribs.

An inspection of the chest is now made, and note is taken of any adhesions that may be found. The adhesions vary to a great extent; they may be few and of the lightest texture, breaking down with the gentlest handling; they may be almost universal, requiring a firm effort to separate them; they may be of the utmost density, ¼ inch in

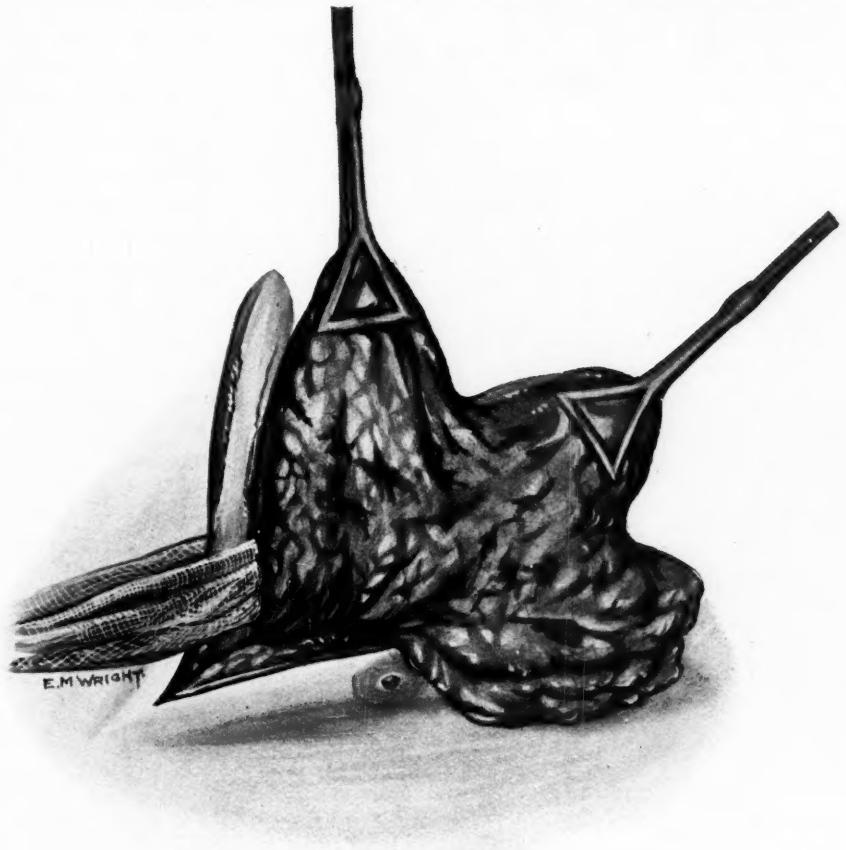

FIG. 390.—The lung brought out on to the surface of the chest.

thickness, so firm and strong that a separation with the finger alone is quite impossible. I have several times had to cut away, with the scissors, plates of lymph as thick as felt, before I could liberate the compressed lung. As such adhesions are removed, the lung is seen to expand. It has been my practice always to separate every adhesion as the first part of the intrapleural stage of the operation.

I have felt, rightly or wrongly, that the restriction of the free expansion of the lung by adhesions was to be considered as perhaps the most essential point of the operation. The separation of adhesions, except those of the toughest sort, is best carried out by the procedure of 'gauze stripping' which is adopted in the separation of a hernial sac. On separating adhesions, cavities containing old blood-clot may be found. On one occasion

such a cavity contained not less than a pint and a half of old blood-stained fluid of the colour and consistency of thick cocoa. On two occasions I have found the remains of an empyema which had not been opened. These conditions could not be discovered unless the adhesions were methodically and habitually separated. The adhesions bleed freely, but the hæmorrhage is very easily and rapidly checked by the pressure of hot moist swabs, one or two being left in the cavity while the operation proceeds. I have sometimes felt the projectile drop into my hand as the adhesions were being separated; the foreign bodies lay not so much in the lung tissue as in adhesions binding the two pleural surfaces together.

When the lung is freed the projectile may be sought. It is easier to find a metallic foreign body in the lung than in any other part of the body. When the organ is gently grasped in the fingers a local hardness is felt at once. The part of the lung which holds the metal is then brought to the surface. It is astonishing to find with what ease the posterior part of the lung, for example, can be brought forward to the wound, and held there while the foreign body is extracted. The mobility of the lung, and the ease of handling it, are very remarkable. The lung may be grasped with the hand, or held lightly in the specially devised lung forceps of Duval (*Fig.* 390), the grasp of which is firm and delicate. When the lung containing the projectile has been lifted forward, the depth of the missile from the surface is gauged, and steps are taken to remove the metal. A pair of blunt forceps may be pushed through the lung substance until they impinge on the bullet, the blades are opened, and the body is grasped and gently disentangled from the lung. Or an incision may be made through the lung directly down to the body (*Fig.* 391), which is laid bare and removed. The wound in the lung is now touched with pure carbolic acid, and closed by catgut sutures which closely approximate the pleural edges.

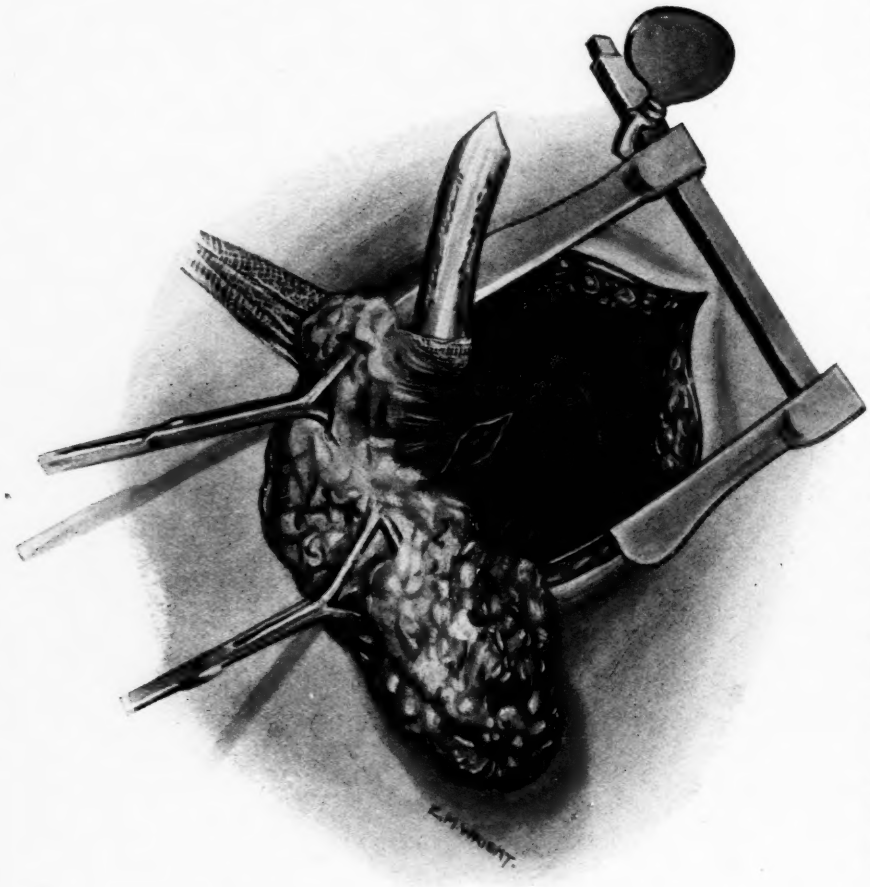

FIG. 391.—Position of a foreign body indicated, with the incision into the lung to expose it.

The condition of the lung around the retained metal varies. Sometimes a small abscess cavity is discovered, the pus being dried and hard; sometimes a hard fibrous mass encases the metal; sometimes there is a dark-red area of hepatization; quite often there is no appreciable change in the density or appearance of the lung tissue.

Throughout all the manipulations the lung is handled with extreme gentleness. The light hand and the tender caress are as necessary in this branch of surgery as in all abdominal operations, and equally repay the surgeon in the quick and quiet recovery of his patients. The heavier the handling of the lung, the greater appears to be the subsequent respiratory distress from which the patient suffers.

The wound in it being closed, the lung is allowed to drop back into the chest, and pains are taken to see that all the fluid is removed. Bleeding must be checked by pressure, for the exudation of even four or five ounces on the day following operation is enough to cause distress. The retractor is now removed, and steps are taken to close the pleural wound. I have rarely been able to close the pleura with that perfect coaptation of the surfaces that is so easily obtainable in the peritoneum. The apposition is often very difficult, especially at the inner end of the wound, and the stitch may cut through if any special tension is put upon it (*Fig.* 392). Help may be obtained by passing one strong suture round the ribs above and below, and dragging them closely together.

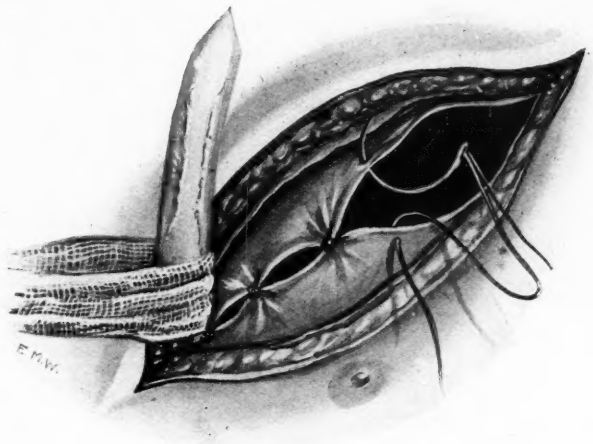

FIG 392.—Suture of the pleura.

In early operations I wiped the lung wound over with ether and left a little ether in the chest cavity. It rapidly evaporated, and at the completion of the operation I aspirated the chest, drew the ether vapour away, and allowed the lung to expand at once. This is neither necessary nor prudent, for the collapse of the lung helps hæmostasis, and the air left in the pleura is very rapidly absorbed.

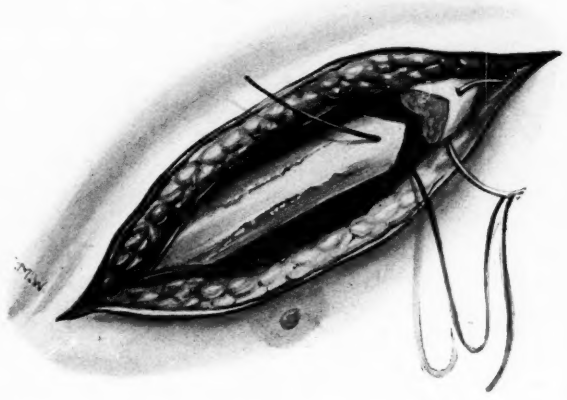

FIG. 393.—The rib replaced and the costal cartilage sutured.

The rib is now replaced: a stout catgut suture passed through the costal cartilage holds the ends in apposition, and this is helped very much by the dovetail incision which was made to divide the cartilage (*Fig.* 393). Over the rib the pectoralis minor muscle is sutured, and the fibres of the pectoralis major are brought together by three or four stitches. The pectoralis fascia is carefully sutured in all its length, and finally the skin is closed by a continuous suture (*Fig.* 394). As a rule no drainage is used; but in two cases in which the bleeding was free I put a small drain in posteriorly for twenty-four hours, and I think the patient's comfort was increased thereby.

It is impossible to displace the hilum towards the surface, and all the rather difficult and often tedious manipulations have to be carried out inside the chest.

When the projectile is on, or in, the heart muscle, it is convenient to put in one or two sutures above and below, or to the sides, so as to hold the heart steady while an

incision is made. On one occasion only I have found an isolated dried hard mass of calcareous material in the lung, which was possibly a cured local tuberculosis. On four occasions fragments of clothing have been found lying with the projectile.

AFTER-COURSE.—As a rule the after-course is simple. The following complications may be seen ;—

Hæmoptysis.—This has occurred 7 times in 49 cases. As a rule it is of the slightest, and causes no concern : once only have I seen a degree of hæmorrhage which could be assessed at 3 or 4 ounces, occurring in the first twenty-four hours

Respiratory Distress.—This occurs rarely. It has only been noticed in cases where a multitude of severe adhesions had to be separated, and the lung rather heavily handled. In 12 cases an effusion of blood or serum has been discovered on the third or fourth day, and aspiration has given a relief that was striking in proportion to the amount of fluid removed.

Emphysema. — Surgical emphysema has developed in several cases, especially those in which a poor apposition of pleural surfaces was obtained. It has twice spread over the neck and face. It has always rapidly disappeared, and has never been a matter of distress.

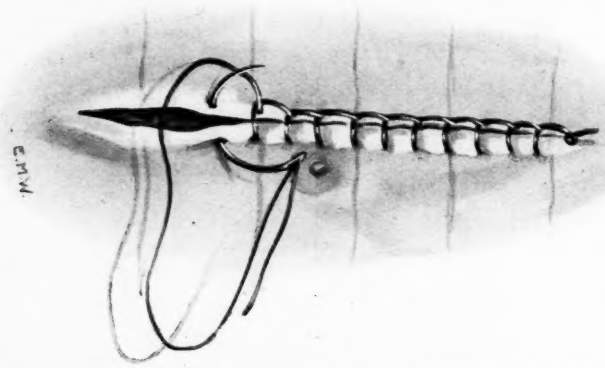

FIG. 394.—Closure of the skin wound by continuous catgut or horsehair suture. The scratches made on the skin ensure accurate apposition of wound edges.

Infection of the Wound, or of the Pleural Cavity. Empyema.—In 10 cases empyema had been present before operation. There were, as I have said, 12 cases in which effusion of blood occurred into the pleural cavity after operation ; of these, 5 developed empyema. In every such case the foreign body was infected. In the remaining 7 cases aspiration was performed, and the chest condition rapidly cleared up ; in 6 of these cases the foreign body was sterile, and in 1 infected. The infection which occurs is undoubtedly the result of contamination of the wound at the time of operation, for, with one exception where pneumonia occurred, the organisms recovered from the wound discharges or cultivated from the opened empyema were identical with those found on the projectile. These organisms are coliform bacilli, streptococci, and staphylococci.

An examination of the metal fragments removed shows that a prolific growth of organisms can be cultivated from them years after the infliction of the wound. The question as to the wisdom of freeing adhesions in all directions in the presence of an infected body will be referred to later.

4. **Operations upon the Root of the Lung.**—The root of the lung is that part of the pedicle of the lung at the region where the pleura is reflected on to it. The measurements of the root are from above downwards about 30 mm., and from before backwards about 15 to 18 mm. The surface marking *in front* is the 3rd costal cartilage and the adjacent intercostal spaces on each side ; and, behind, the inner end of the 5th rib and the adjacent intercostal spaces on each side. In the root of the lung lie the bronchi, pulmonary artery and veins, bronchial artery and veins, lymphatic glands and vessels, and nerves. The glands are numerous. The pedicle enters the lung at a vertical notch, the hilum, about 45 to 50 mm. long and 25 mm. broad.

The special considerations in connection with operations upon the root of the lung are, chiefly, the extreme vascularity of the part, its fixity, and its physical properties.

The number of vessels is great and their size formidable. A wound of the root of

the lung should be inflicted with extreme caution, for if a vessel is wounded it is exceedingly difficult to arrest the hæmorrhage. It is almost impossible to secure the vessel and to ligature it in the ordinary manner. If a suture is passed round the vessel, it is likely that other vessels will be wounded by it. For this reason many of the French surgeons advise the plugging of the wound with gauze, which is left in position for two or three days.

One of my two fatal cases died from hæmorrhage. The projectile was embedded in the root of the lung. After its gentle removal there was free hæmorrhage, which appeared to be arrested by the sutures I passed for this purpose. The patient died in a few hours, and the pleura was found filled with blood. The error in technique was grievous, and the warning for similar cases did not go unheeded.

The fixity of the root makes all operations upon it far more difficult than those which engage other parts of the lung. It is really surprising to find with what ease all parts of the lung can be brought forward to the wound made by the elevation of the 4th or 5th rib, incised, and carefully sutured. The root of the lung is almost immobile. The operator must go down to it : he cannot bring the parts nearer to him. All the steps of the operation can, and should be, visible to the surgeon : nothing need be done in the dark ; but the remoteness and the immobility render all manipulations much more difficult than they are elsewhere. All technical procedures at the root of the lung are made easier if the parts near the hilum are fixed by the special light forceps of Duval. They not only withdraw the lung from the path of the surgeon, but give a stable field in which to work.

The physical properties of the root of the lung make it exceedingly difficult to distinguish a bronchus from a piece of metal. I have been deceived more than once. When, for purposes of comparison, I have examined the hilum in cases where it was known that no foreign body was lodged there, I have realized how exact was the mimicry of a projectile by the hard, rounded, but irregular condition of a bronchus.

Notwithstanding these several points, there is no need to modify the ordinary open procedure which I have described. Some surgeons have preferred the flap operation, which, as Le Fort has shown, is especially applicable in some operations involving the mediastinum. That more room is thereby gained is indisputable ; but more room is never needed, for all requisite manipulations are possible through the ordinary incision. The flap method is certainly a little more formidable ; inflicts a greater damage on the chest ; and implies a more protracted convalescence, and perhaps a weaker chest wall in days to come.

Le Fort himself (*Bull. et Mém. Soc. de Chir.*, 1917, p. 1142) obtains adequate room by making an intercostal incision, dividing the costal cartilages above and below, and displacing them upwards and downwards by strong retractors. An approach to the hilum from behind is advised by Petit de la Villéon (*Bull. et Mém. Soc. de Chir.*, 1918, p. 976), who describes an area bounded on the inner side by the spine, on the outer by the border of the scapula, above by the 5th rib, and below by the 8th rib, as that in which the shadow of the root of the lung falls. If a piece of metal is seen in this area, and is gauged to be at a depth of from 6 to 13 cm. from the posterior surface, it lies in the root of the lung. His operation is practised in three stages :—

Stage 1.—Performed in a strong red-orange light. The patient lies prone. The omovertebral space is opened, and resection of the necessary ribs (6th, 7th, and 8th) is performed ; the resection is made as wide as possible to give free access. The pleura is opened.

Stage 2.—Performed under *x* ray, with screen examination. A long pair of forceps is passed through the visceral pleura and the lung to the hilum. Guided by the image on the screen, the forceps seizes the foreign body, grasps it, and is held steady.

Stage 3.—In daylight. The forceps is withdrawn with the projectile. Into the wound made by the forceps the surgeon plunges his left index finger ; this he gradually withdraws, packing gauze in long strips into the cavity it occupied. The wound in the parietes is closed. The packing remains for forty-eight hours, being loosened first by

hydrogen peroxide. It is thought that the free pneumothorax aids in hæmostasis. Sixteen cases are recorded, with 16 recoveries. In none was there any hæmorrhage.

The method of Petit de la Villéon has obtained a degree of success denied to all other procedures. It requires a special installation of light and *x* ray, and an apprenticeship on the part of the operator in the extraction of foreign bodies under screen examination. Its success depends upon details; but its success is no detail. Probably a combination of the anterior operation with a screen examination at the time of searching within the hilum for the projectile would be an improvement upon the original method. And no small part of the success of the operations performed by Petit de la Villéon depend upon his fully-trained capacity for details and for dainty operations of this type.

5. **Operations upon the Mediastinum.**—

Access to the mediastinum may be obtained either by the operations already described, in which one rib alone is elevated or removed, or by methods specially devised to give ample access. Of these special methods the following may be briefly described.

1. *The costal flap with external hinge of Delorme, modified by Le Fort* (whose description I give).—

This flap is cut widely and regularly by dividing the costal cartilages and the intercostal spaces at equal distance from the bordering ribs (so as to permit the repair of the wall); it is then raised, guarded against fracture of the ribs either by simple elevation if the flap can be extended very far outward, as is the case with the lower ribs, or by causing a greenstick fracture by strong but cautious pressure, as can be done in the majority of patients up to and even above thirty years of age.

This procedure provides the most light, permitting complete exploration of the entire thoracic cavity, from the clavicles as far as the diaphragm, and from the sternum to the vertebral column and the ribs behind. It facilitates all manipulations, the introduction of both hands and instruments into the interior of the thorax, and the direct inspection of the entire cavity. Very recently I succeeded without difficulty in obtaining hæmostasis of the wounded azygos major vein behind the diaphragm, by means of an anterior flap.

2. *Le Fort's method of intercostal incision associated with division of the supra- or subjacent costal cartilages.*—

As in the case of the flap with an external hinge of Delorme, the procedure causes no mutilation of the thorax. The repair of the wall is easier and can be made even more accurately than after the Delorme flap, and the operation is perhaps even more free from danger. The procedure permits the breach in the chest wall to be made more or less extensive according to the necessities of the case. A simple incision of one intercostal space permits separating the ribs by about 6 cm.; division of the cartilage above or below permits of a separation of 8 cm.; division of both cartilages together gives an opening of about 12 cm., and the supplementary division of another cartilage enables one to enlarge the separation to 19 cm. It is very advantageous always to make the incision in an intercostal space slightly below the level of the foreign body which is to be extracted. This way of proceeding has a twofold advantage: on the one hand, the avenue of access supplied by the incision of an intercostal cartilage is so much the larger the lower the intercostal space; on the other hand, the intercostal incision combined with incision of the costal cartilages above can be very easily transformed into a costal flap, by simple section of a higher intercostal space.

3. *The sternocleidocostal flap method, suggested by Duval.*—

This operation provides free access to the cervico-mediastinal 'cross-roads', to the arch of the aorta, the origin of the carotids, the brachiocephalic trunks and the subclavian veins, the internal portion of the apex of the lung, and the entire half of the superior mediastinum, without sacrificing the clavicles, without opening the sternocostoclavicular articulations, without damaging any organ, vessel, nerve, or important muscle. It consists in turning upward and outward a flap which comprises the clavicle, the first rib, and the upper outer segment of the sternal manubrium where these bones are inserted.

4. *Median division of the sternum, pericardium, and diaphragm—Duval's method.* This provides free access to the heart, and is recommended for certain operations

upon the right heart. Sometimes it may be desirable to add to the flap with an external hinge, a small sternal flap with an internal hinge, etc.

The detail of these procedures does not really make much difference. The indispensable requirements are to provide all the necessary light for the operative intervention by means of a large gap, which can be further enlarged should an unexpected necessity arise ; and to avoid all permanent mutilations, so as to permit an essential repair of the thoracic wall after the completion of the operation.

The relative advantages and difficulties of these several methods have been briefly indicated in the description of each. For the removal of small projectiles lying free in the lung which has no serious adhesions to the chest wall, the method of Petit de la Villéon is the easiest, safest, and least disturbing.

For all foreign bodies in the hilum, or in the mediastinum, or in the heart, an open operation is necessary. For many of these the operation in which one rib is elevated and resected is generally adequate. If it is necessary to have more ample space and a better view, the operations of Delorme, Le Fort, or Duval will be performed. The operation of Petit de la Villéon, in which the hilum is approached from behind, appears to be attended with great success, but, so far as I can learn, has been practised only by him.

D. AFTER-HISTORY AND RESULTS OF OPERATION.

To my regret it has not been possible to make such comparison as I consider necessary between the conditions of the patients before operation and afterwards, especially months afterwards. The men upon whom I have operated are scattered about the country from Aberdeen to Cornwall ; most of them are back at work, and it has been quite impracticable to get them to come for a medical and radiological examination. In most of the cases I have therefore to rely upon the patients' testimony. It is not certain that this is always as satisfactory as it might be ; for more than half the men make some bitter reference to the dealings of the Pensions Ministry with them ; of reductions which they consider untimely, or unfair, in the weekly pension. Some of the letters seem to express a fear that a too favourable report may result in a pension, already meagre, being further reduced : but the evidence is the best accessible. I have accordingly written to all patients, and their answers are given in the appended case reports.

As a class, these reports contrast in a very striking manner with those which I received almost at the same time from some of the patients upon whom, in recent years, I performed partial gastrectomy for gastric ulcer or gastric cancer. In the pleural cases it is comparatively rare to find the patient saying that he is entirely free from trouble. There is not infrequent reference to breathlessness on exertion, or to a little pain. There is rarely any mention of cough, and none of hæmoptysis. These two conditions are certainly relieved by the removal of the foreign body ; but the functional troubles persist in some degree.

Does the persistence of some of these symptoms depend upon the operation performed ? Is it, for example, a wise procedure to separate all adhesions binding the lung to the chest wall ? In the presence of numerous and strong adhesions there does not appear to be necessarily any pain, nor any shortness of breath except on exertion. It is true that the lung then acts imperfectly, that it shows evidence of collapse in greater or less degree. My hope was that the free and open operation which I have customarily performed, together with the fearless separation of all adhesions, might do something to restore the lung to its full free function. And in some cases this hope has certainly been fulfilled. It is a very striking phenomenon to witness the gradual expansion of the lung when thick adhesions are separated, or tough heavy membranes stripped from its surface. The lung grows bigger and fuller under one's eyes, and it is evident that there has been compression as well as a willing collapse on the part of the lung. But in some cases the results that have followed have been below my expectations. As some of the late reports show, there is evidence still of restricted capacity for breathing, of effort dyspnœa, and of some pain. And the physical examination shows also that in some cases a degree of

collapse is still present. The most certain test of a lung's free activity is perhaps afforded by an inspection of the range of movement of the diaphragm watched on the *x*-ray screen. In several patients there has been witnessed an increasing range, as function was restored. In a few of our patients the mobility of the diaphragm did not visibly increase.

The condition of the elevated rib is in all cases quite satisfactory. Sound union has occurred; and the chest wall may be said to be as strong and firm as ever.

SUMMARY.

The following is an epitome of my experience: 49 cases have been treated by operation: 2 cases have died, one from hæmorrhage following the removal of a projectile from the root of the lung, and one from sepsis after the removal of an infected foreign body and a piece of clothing.

The late history has been obtained in 43 cases. The results may be described at *Good*, *Fair*, *Bad*.

1. *Good Results.*—These patients are, they say, in perfect health, and are able to do heavy work. Of these there are 24, equal to 55·8 per cent.

2. *Fair Results.*—Some of these patients are better than before operation, but still have some shortness of breath, or unusual respiratory trouble when having a cold, or in bad weather. Some are a little better since the operation. Of these there are 14, or 32·5 per cent.

3. *Bad Results.*—Two patients died; 3 are unable to do any work, or have serious respiratory trouble, shortness of breath, cough, etc.

The position of the foreign body in the 49 cases was as follows:—

	Left lung.	Right lung.
In upper lobe	4	4
In middle „	—	1
In lower „	10	13
In root	5	2
	19	20

In and adherent to pericardium	4
In heart muscle	1
In diaphragm	1
In pleural cavity (loose)	1
In body of vertebra	1
Not mentioned	1
? Present (lung gritty and probably tuberculous) ..	1
	10

All but 5 were operated on by the ordinary anterior method. The 5 operated on by direct attack from behind show 4 with good ultimate results, 1 with fair result.

Eighteen of the foreign bodies were examined bacteriologically; 11 were infected with *Staphylococcus aureus*, or *Streptococcus brevis* in equal numbers, or by these organisms together with coliform bacilli; 7 were sterile.

Empyema after operation developed in 5 cases, and in each of these, when the foreign body was examined, it was found to be infected. In 12 cases blood collected after operation in sufficient quantity to require aspiration. In all these the adhesions were dense, and were widely separated. These 12 include the 5 reported above which subsequently developed empyema. Of the 7 which did not suppurate, only once was the foreign body examined, and it was sterile.

In 10 cases the original injury had been followed by empyema. The only effect this had at the time of removing the foreign body was that adhesions were found to be very dense and extensive. Three cases were reported as having had hæmothorax at the time of the original injury; at the operation for removing the foreign body, adhesions were dense; in two of these three cases an exceedingly thick blanket-like membrane had to be removed by scissors to allow the expansion of the lung.

E. LIST OF CASES TREATED BY OPERATION.

Case 1.—**Projectile in apex of left lung. Removal.**

J. C. M., age 22. Pte. Admitted June 18, 1917; discharged Sept. 25.

Wounded May 13, 1917. Entrance over vertebral border of scapula just below spine. Hæmoptysis for one week; no suppuration; now complains of pain in left side of chest; no cough; not getting about except to lavatory; feels well; no dyspnœa.

X-ray examination discloses square piece of metal ¾ inch broad and long, in deep part of neck (? apex of lung) on left side. Previous attempt had been made in France to remove this piece of shrapnel. Breath, sounds diminished, and also vocal fremitus in left axillary line below level of nipple; no heart displacement; no diminution of movements.

Operation Aug. 17, 1917.—Collar incision just above left clavicle. Only muscle cut was scalenus anticus, and this merely nicked. By careful feeling and cautious blunt dissection the necks of 1st and 2nd ribs were found, and foreign body localized with Dr. Hackett's telephone apparatus. It was found necessary to open pleura, as the foreign body, together with a piece of shirt, lay in apex of lung. Wound in lung closed by one stitch Sept. 17. Chest signs as before operation; wound healed.

Report, Dec., 1919.—"All O.K. Had almost forgotten I had had an operation done."

Case 2.—**Foreign body in lower lobe of right lung. Removal.**

J. W., age 22. Pte. Admitted June 18, 1917; discharged Aug. 17.

Wounded Sept. 25, 1916. Entrance at sternal end of 7th right costal cartilage. Had hæmoptysis for two months; no suppuration; now complains of cough and pain in right side. Diminished movements of right side of chest; also marked diminished air entry, especially at base in front; heart displaced a little inwards.

Operation, June 29, 1917.—About 4 inches of 4th right rib removed in front; and by this means an opening made large enough to put hand inside chest. Extensive and firm adhesions of pleural surfaces. With perseverance, adhesions were freed and posterior chest wall palpated; the piece of shrapnel was found in posterior part of lower lobe and was removed. Fibrous track of the bullet could be felt in lung quite easily. Much bleeding; easily stopped. Ether vapour admitted and drawn off again after stitching up the wound. Convalescence uninterrupted.

In spite of several applications we have not been able to get a recent report from this man. His condition when he left the auxiliary hospital was 'perfect.'

Case 3.—**Shrapnel ball in upper left lobe. Removal.**

E. T., age 32. Rfmn. Admitted Aug. 2, 1917; discharged Sept. 25.

Patient was admitted complaining of pain in chest, cough, fœtid expectoration, and shortness of breath. Wounded July, 1916. In hospital over a year; no diminution in severity of symptoms; says he "cannot get about without difficulty and great distress in breathing; always has heavy colds and cough." Shrapnel bullet in the left lung.

Aug. 5, 1917.—Needle passed into lung through 3rd space in front moves freely during respiration in the opposite direction to the chest wall.

Aug. 6.—Physical signs suggest fluid at left base; none found, however, on aspiration.

Aug. 9.—Complained of some change in sight since being wounded. Examination of the fundi does not reveal any abnormality.

Operation, Aug. 10.—About 4 inches of 3rd left rib removed in front; space dilated with special retractor. Pleura opened; some few adhesions, no fluid; lung collapsed on opening the pleura. Foreign body felt just beneath anterior edge of lung, lying in upper lobe and about opposite 3rd rib. Lung incised over bullet, which was removed from a hard-walled cavity that contained also a piece of cloth. Wound in lung closed by three catgut sutures; parietal wound closed after introducing some ether; ether vapour drawn off with a syringe after stitching up wound.

Quite ordinary convalescence, except for first four days, when temp. (100°), pulse (108), and respiration (36) were all raised, but gradually fell to normal.

Report, Dec. 31, 1919.—"I am working at my old work as a miner. My rib has never grown up again; you said I was a bit too old for it to do that. I started to work a bit too hard at first, and so had to rest, as I was so tired in the mornings. The bad weather does not suit me; though there are many a deal worse than me."

Case 4.—**Foreign body in lower lobe of right lung. Removal.**

T. A. R., age 22. L.-Cpl. Admitted Aug. 14, 1917; discharged Sept. 25.

Wounded June 21, 1917, one inch below angle of right scapula. Wound healed; no hæmoptysis at any time. Except for a little cough a day or two after being wounded, no trouble in that way. Only complaint, shortness of breath after walking—more than he considers normal. On puncturing behind with a needle, the pleura feels thick and the movements of the needle are very small.

X-ray Report, Aug. 11, 1917.—Fragment of shrapnel lying directly under X mark over 5th rib 1¾ inches from middle line on right side. It is in the lung and at a depth of 6 inches from anterior

surface ; moves downwards on inspiration. Appear to be no adhesions of lung to chest wall. No sign of fluid in the pleural cavity ; no fractured ribs.

Medical Report, Aug. 15.—Movement of right side of chest slightly impaired at lower part ; the note is not so good as at left base, and vocal fremitus is also lessened. Breath-sounds much feebler on right side behind than on left at base ; heart normal ; any slight irregularity is of the sinus variety.

Operation, Aug. 17.—Fourth right rib in front turned back ; pleura opened ; lung collapsed at once. Many adhesions—particularly behind and to diaphragm. In the latter situation a splintered rib was found, and in the lung over this the foreign body was felt and removed. Ether applied over wound in lung. Wound stitched up ; rib replaced ; aspirated. Convalescence uninterrupted.

Sept. 17.—Still very little entry of air into lower lobe on right side. Wound healed and patient well.

Report, Dec. 28, 1919.—" I am pleased to say, considering the operation it was, I have got on well. I feel no pain where I had the operation, but often do under the shoulder blade where the metal went in. The only bad time I have is when I get a cold. The doctor tells me I am all right."

Case 5.—**Foreign body in lower lobe of right lung. Removal.**

A. T., age 24. Cpl. Admitted Aug. 18, 1917 ; discharged Dec. 28.

Wounded April 21, 1917. Three small wounds, nearly healed, over upper part of chest in front. Two lie over the manubrium sterni, and the third to left of it. Hæmoptysis from first day for eight weeks ; slight cough at first ; bronchitis and pneumonia on right side before admittance. Complains now of stabbing pain in right shoulder, coming on at any time ; also of shortness of breath on slightest exertion.

Medical Report, Aug. 18, 1917.—Slight displacement of apex beat to left ; no degree of cardiac mischief ; percussion note in right lower axillary region is a little impaired. Certainly not enough dullness here to associate with displacement of apex beat, that is to say, if there is any fluid at all in right chest, which I greatly doubt : not enough to account for displacement of apex beat. Movements of lower part of right chest impaired slightly, otherwise examination is negative.

X-ray Report.—Three pieces of metal : (*a*) One 4½ inches from anterior surface in upper right lobe, moving slightly with the lung ; (*b*) One behind sternum, and probably adherent to it ; (*c*) Embedded in soft parts of chest wall.

Operation, Sept. 7.—Oxygen and ether. Piece of 4th right rib removed in front. Lung closely adherent to pleura. After some stripping, foreign body felt in lower lobe, and after scratching through a thin film of lung, it fell into the surgeon's hand. Wound closed as usual. Ether : aspiration. The other two pieces not removed, as patient was not comfortable under anæsthetic. Patient had an easy convalescence, though foreign body was an infected one (prolific growth of *Staphylococcus aureus*), causing wound to suppurate. Eventually healed, and, when discharged, condition of chest was much the same as before operation ; patient said he breathed more easily and had much less distress on exertion.

Report, Jan. 9, 1920.—" I wish to state that in myself I feel very well. The only complaint is that I cough and spit on rising in the morning. I am following my employment (as a miner) about three to four days a week, and stand that fairly well."

Case 6.—**Shadow of (?) foreign body. Exploration. No metal found. 'Gritty' condition of lung. Tuberculosis.**

J. McM., age 19. Admitted Aug. 21, 1917 ; discharged Dec. 15.

Wounded April 10, 1917. Shrapnel entering to inner side of left scapula. Very short of breath at the time, and breathing painful ; no hæmoptysis ; bad cough for fourteen days ; much sputum.

Still has a slight cough, and is short of breath on least exertion. Very nervous.

Medical Report, Aug. 25, 1917.—Left chest expands very badly, and breath-sounds barely audible back and front. A few moist sounds heard near upper part of lower lobe behind, on deep inspiration. A cough, which at times is very troublesome, so that he can hardly breathe. Wound healed. Some hyperæsthesia over chest in front. If he moves in bed he sometimes gets an 'awful pain,' which passes to back of shoulder.

X-ray Report, Sept. 4.—Small fragment of metal in left upper lobe of lung. It moves upwards and downwards with respiration, and is 3½ inches deep from the X mark on anterior chest wall. Movements of lung appear quite normal ; no sign of bony injury to ribs.

Operation, Sept. 7.—Piece of 4th left rib removed in front. Lung fell away on opening the pleura. The whole upper lobe of left lung was delivered on to chest wall and carefully palpated. The lung was out for thirty to forty minutes without slightest disturbance to patient. A swab was packed into chest and caused marked cyanosis and interference with respiration (? packing against the pericardium).

Palpation of lung revealed nothing in nature of a foreign body except at root, where a small hard lump was discovered and felt like metal. However, after incising on to this, it was found to be a bronchus. Three stitches were put into root of lung to close this incision ; two of these also served to arrest bleeding. The whole upper lobe of lung felt a little 'gritty' on palpation. The lower lobe was also palpated, but not delivered ; nothing felt in it. Wound closed. Ether vapour : aspirated.

The night of the operation patient had great difficulty with breathing, which was also rapid and shallow. Pulse rapid.

Sept. 8.—Breathing much quieter; recovery uninterrupted.

Nov. 13.—Practically no entry of air into left upper lobe and very little into lower. Cough not much better, but feels he can "get the phlegm up better." Pain a little easier; is getting about and gains weight.

Nov. 18.—*X* rays show shadow still seen in chest (left); it is 1 inch below and slightly internal to previous marking. No improvement on respiration. It is 3⅜ inches deep from the mark on chest wall (anterior). A little patchy opacity of upper lobe; lower lobe appears quite normal.

Report, Dec. 16, 1919.—"Your letter to hand this morning for which I thank you very much. Since leaving the Infirmary after my operation I was at East Leeds Hospital, Gledhow Hall, and Cookridge, but did not show any improvement, so I was discharged in April, 1918. I have had some very bad times since, with pain in my chest and breathing very bad indeed; it is not good even now. The Pension Commissioners took up my case, and they sent me as convalescent to Scarborough, where I pulled round a little, but I never put any weight on. Then they suddenly found I was suffering from tuberculosis, for which they treated me up to a few months ago, and they told me I was fit, and I was feeling anything but well. I am feeling a little better now, so after nearly two years I have started work as a traveller, as I thought open air would be better for my health. Well, Sir, I thank you many times over for your kindness to me at my operation, and if you wish to see me I am at your convenience."

Case 7.—**Foreign body in left lower lobe, adherent to pericardium. Removal.**

A. W. H., age 21. Admitted Aug. 27, 1917; discharged Oct. 29.

Wounded Feb. 18, 1917. Entrance at level of 11th left rib behind. Had hæmoptysis for about three days; cough and blood-stained sputum for seven or eight weeks. Chest signs negative; heart sounds normal; now complains of pain over heart, shortness of breath, and cough.

Operation, Sept. 3, 1917.—Oxygen and ether. Third left rib reflected; piece of metal removed easily from just within lung, and adherent to pericardium. Rib replaced by stitch. Ether and aspiration. Patient perfectly comfortable same evening, after returning to bed; convalescence uninterrupted. Temperature normal throughout, pulse 108, respirations 30 for first day, dropped to normal next day.

Returned to active service March, 1918; demobilized June, 1919.

Report, Dec. 18, 1919.—"The result of the operation is marvellous, and I count myself lucky to be alive and as well as I am. I cannot do any very heavy work, as I suffer then with shortness of breath and headaches."

Case 8.—**Foreign body in left lower lobe. Removal by posterior incision.**

T. S., age 23. Admitted Aug. 31, 1917.

Wounded Aug. 13, 1917. Gunshot wound of left chest. Entrance wound over centre of left clavicle (this bone was fractured). Hæmoptysis for two days and shortness of breath. All symptoms gone now; no chest signs.

Operation, Sept. 7, 1917.—Piece of metal removed from inside left chest after resecting piece of rib (about the 9th) behind. This rib was fractured. Wound closed. Foreign body sterile after forty-eight hours' cultivation; localized 1⅜ inches in front of posterior surface by *x* rays. No movement on respiration; perfect rapid convalescence.

Report, Dec. 7, 1919.—"I have had no trouble with my chest since I left hospital. I consider the operation was a good success."

Case 9.—**Foreign body in root of left lung. Removal.**

J. J., age 20. Pte. Admitted Nov. 18, 1917; discharged June 24, 1918.

Wounded Oct. 1, 1917. Gunshot wound of left side of chest just below axilla. Cough and hæmoptysis for about three days; short and painful breathing. Since first three days, shortness of breath and a stabbing pain on breathing. These are gradually disappearing. Still short of breath, cyanosed, but very little pain. Complains of flatulence and fullness after meals; severe constipation.

X-ray Report, Nov. 26, 1917.—Much opacity of left lower lobe. A small fragment of metal 3⅞ inches deep directly under X mark over inner end of 2nd rib; moves slightly inwards on deep inspiration; no downward movement. Apex beat in normal place. I think, from position and movements, metal is in mediastinum.

Medical Report, Dec. 11.—Left side of chest not quite so full as right (as seen from behind, region internal to and below scapula is less full). Semicircumference at nipple level is 1 inch less on left than right side. Note on left side slightly impaired; stomach note rather higher than normal in lateral region; vocal fremitus good, but breath-sounds feeble; heart normal; pulsation rather more visible than usual, probably due to slight collapse of left lung.

March 19, 1918.—Condition of chest much the same as before; semicircumferences 16 to 17; note not so good on left as right side; breath-sounds feeble; cardiac dullness rather more extensive than usual, due probably to slight collapse of lung. As no improvement occurred in respiration, operation was advised.

Operation, May 17, 1918.—Third left rib reflected; lung adherent all over, so that there was no pleural cavity; lung separated also from pericardium, and foreign body felt at back of root of lung, close to descending aorta behind. Reached with a blunt instrument, which was worked gently towards it, guided by the finger. The instrument was used in a very gentle 'scratching' manner; no stitch was placed in the pedicle. Wound stitched up as usual; very little bleeding throughout. Convalescence quiet and uneventful.

Report, Dec. 9, 1919.—"I may state I have kept fairly well since I came home. I am working at a light job when fit. I was off three weeks ago. My right lung swelled up a little, but came all right after a rest. I have not got settled yet about my pension. I am receiving £1 per week for 22 weeks pending a Medical Board."

Case 10.—**Foreign body in diaphragm. Old empyema. Removal after resection of 5th rib. Foreign body infected. Empyema; drainage. Recovery.**

B. C., age 23. Admitted Dec. 1, 1917; discharged Sept. 20, 1918.

Gunshot wound of right chest behind, of left buttock, and back of left thigh. Wounded Oct. 21, 1917. Hæmoptysis for first day, with short, painful breathing; had hæmothorax, which suppurated and was drained; healed up six weeks ago; now complains of shortness of breath and pain in right side on exertion; very prone to bad chills and coughs; blood noticed twice in small quantity; pus frequent in expectoration. Has had a great deal of indigestion and flatulence.

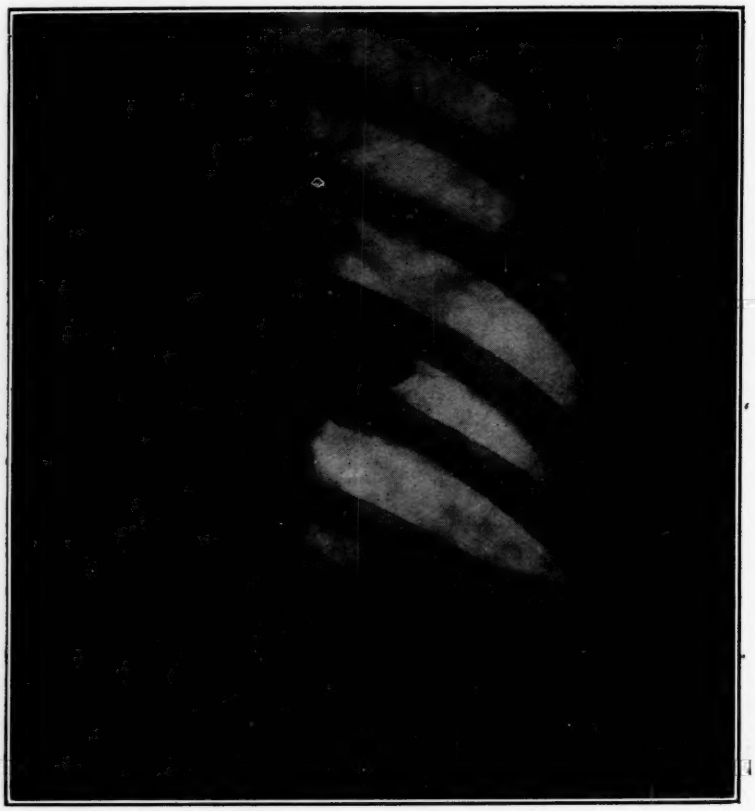

FIG. 395.—*Case* 10. Very large fragment of shell-casing removed from lower lobe of lung behind. Old empyema. Many adhesions of great density. Excellent recovery.

Medical Report, Dec. 30, 1917.—Two semicircumferences of chest equal; movements slightly impaired on right side; at right apex some hyper-resonance, probably skodaic. Some dullness at right base, with lessening of fremitus and breath-sounds; no adventitious sounds; no cardiac displacement. These signs are quite compatible with there being no fluid in chest, but with imperfect expansion of lower part of right lung; that is, the empyema operation may be quite satisfactory.

X-ray Report, March 30, 1918.—Middle and lower lobes quite normal in appearance; the arch of the diaphragm (right) moves quite freely. The fragment of metal is 2 inches deep from X mark on anterior surface, just below nipple; slightly higher than on examination four months ago; moves freely upwards and downwards on respiration. I think it is in anterior part of right lower lobe. (*Fig.* 395.)

May 15.—The metal is in same position as on previous examination. Very slight downward movement on respiration ; only slight movement of right arch of diaphragm.

Operation, June 8.—Fifth right rib reflected ; dense adhesions between lung and pleura obliterating whole cavity ; most dense in neighbourhood of diaphragm, with which lung was in a state of cohesion. After separating lung with much bleeding (easily controlled) from diaphragm and the rest of the parietal pleura, the foreign body, with an offensive piece of cloth, was found in the substance of the diaphragm and removed. Re-formed pleural cavity swabbed out with ether ; wounds stitched up as usual. Foreign body contained *Streptococcus brevis* in abundant growth.

June 12.—Two ounces of blood-stained fluid drawn off from right pleural cavity ; no growth.

June 16.—Two ounces pus and blood-stained fluid drawn off, containing short streptococci and occasional clumps of cocci. Culture gives a prolific growth of *Staphylococcus aureus* and streptococci. Empyema opened, drained, and Carrelled. After a stormy convalescence, wound healed ; chest condition " much the same as before operation."

Report, Dec. 9, 1919.—" I am glad to say that at present I am enjoying fairly good health, although my side and chest still trouble me at times. I have been able to do a little light work at home ; but recently, owing to my pension having been reduced so much, I am obliged to work much harder, which is injurious to my health."

Case 11.—**Fragment of shrapnel in lower lobe of left lung. Removal by posterior incision.**

S. W., age 29. Admitted Dec. 6, 1917 ; discharged May 24, 1918.

Wounded July 10, 1916. Entrance wound (healed) over outer end of right clavicle, where there is a well-marked depression. Unconscious for a long time after being wounded. Hæmoptysis and cough for about one month ; in the earlier days had considerable difficulty and pain on breathing. Complains of a cutting pain on taking a deep breath ; no pain on ordinary respiration ; becomes very short of breath when walking, even quietly ; spits up a fair amount of phlegm, sometimes streaked with blood, and sometimes offensive.

Medical Report, Dec. 9, 1917.—The note at the base of right side, behind, slightly deficient ; vocal fremitus good ; breath-sounds at right base feeble. These signs point to slight collapse of lung rather than fluid.

X-ray Report, Feb. 16, 1918.—Fracture through outer third of clavicle, with bony union and antero-posterior displacement and overlapping of fragments. Vertical fracture from upper border downwards and outwards of scapula, involving glenoid cavity (? fracture of coracoid process). Large piece of shrapnel in posterior part of right lower lobe.

Operation, Dec. 21.—Incision in line of 9th rib behind ; 3 inches of rib removed. Pleura incised and foreign body removed from thick fibrous tissue lying in lung, covered by very thick pleura ; lung incised. Cavity left after removing foreign body ; swabbed out with dichloramine-T ; lung sutured. A swab taken at operation contained pus cells largely necrotic and without any organisms. Culture is sterile, and neither tubercle bacilli nor other organisms are found in a smear. Uneventful recovery.

Report, Dec. 9, 1919.—" I am glad to say I am much better than I was before my operation. I have a little cough. There are pains in my right shoulder, which is wasting."

Case 12.—**Foreign body in lower lobe of right lung. Removal.**

J. M., age 20. Admitted Dec. 6, 1917 ; discharged Feb. 25, 1918.

Wounded Oct. 28, 1917. Entrance below the right axilla. Slight hæmoptysis at the time, and cough ; also marked difficulty in breathing, which was painful and short. Hæmoptysis twice since at intervals (quite recently was the last occasion) lasting about one day, just tingeing the sputum. This was one of the reasons for operating. Also shortness of breath on exertion, cough, purulent expectoration, and three severe ' colds.' The wound is tender.

X-ray Report, Dec. 7, 1917.—A small fragment of metal in the middle lobe, 3½ inches deep from the X mark on the posterior surface. It moves freely on respiration upwards and downwards. The lung tissue appears quite normal.

Medical Report, Dec. 9.—On careful examination I can see no difference in the expansion of the two sides of the chest. The note at right apex is a little more resonant than at left (probably skodaic) ; the note at the right base behind is very slightly impaired. No other abnormal signs ; heart normal.

Operation, Dec. 11.—Third right rib reflected. Pleura very adherent to rib, and tore on separating the ribs. Foreign body felt in lower lobe and easily removed by cutting through lung substance on to it. There was smart hæmorrhage from a biggish vessel, which was stopped by stitching. The rib was replaced ; no attempt made to re-expand the lung. Operation followed by a little emphysema in region of wound. On Dec. 16, chest aspirated and about half pint of blood-stained fluid drawn off. Apart from this, convalescence was uninterrupted.

Jan. 20, 1918.—Some emphysema (surgical), especially just above the operation scar. The note is freely resonant over upper part of right chest. Vocal fremitus good, and no definite ' coin sign ' of pneumothorax. Slight displacement of heart. Subsequent progress very quick and satisfactory.

Report, Dec. 24, 1919.—" Everything is all right, and has been since I left the hospital. I have no difficulty in breathing except in the very inclement weather."

Case 13.—**Shrapnel ball in lower lobe of right lung near hilum. Removal. Pneumonia. Empyema. Slow recovery.**

H. S., age 19. L.-Cpl. Admitted Dec. 7, 1917; discharged May 25, 1918.

Wounded Oct. 14, 1917, just below the right scapula, behind. No hæmoptysis or cough at any time; only severe difficulty in breathing. Operated on at this hospital because of shortness of breath and occasional sharp pain on exertion.

Medical Report, Dec. 3, 1917.—No symptoms beyond some shortness of breath on exertion; no evidence of abnormal signs (physical) in heart or lungs.

X-ray Report, Dec. 3.—The bullet is in the anterior part of right lung. Marked opacity over right middle and lower lobes; right half of diaphragm fixed.

Operation, Jan. 11, 1918.—Third right rib reflected; shrapnel ball felt in lower lobe close to root of lung; many adhesions of lung to diaphragm and mediastinum; these had to be separated. Ball extracted; followed by smart hæmorrhage stopped by stitches; rib replaced; no attempt made to re-expand the lung by suction.

Feb. 7.—Culture from foreign body gives coliform bacillus and a few streptococci.

Jan. 25.—Sitting up in ward, quite well.

Jan. 29.—Went for walk outside the hospital, and again on Jan. 30 and on Feb. 1. On this day says he "caught a chill," and signs of pneumonia developed.

Feb. 8.—Fresh consolidation at base of right lung behind; lung has not properly expanded yet.

Feb. 15.—Signs of accumulation of fluid in chest.

Feb. 23.—On *x*-ray examination, marked opacity over right middle and lower lobes. The right half of diaphragm fixed.

Mar. 8.—Empyema drained and Carrelled. Patient, after being very ill, eventually healed up and did well. The chest showed poor air entry at the time of his discharge to a convalescent home.

Report, Dec. 7, 1919.—"I returned to work on the day after Armistice day, and have felt little or no discomfort since then. My pension is reduced to 13/–. I send a photograph, which shows how much I have improved."

Case 14.—**Foreign body in left lower lobe. Removal.**

G. R., age 24. Admitted Dec. 2, 1917; discharged Feb. 25, 1918.

Wounded at Cambrai, Nov. 22, 1917, head, arm, and back. A small foreign body felt beneath skin in temporal region. Chest wound beneath left scapula. No hæmoptysis or cough; but very short and painful breathing. Now complains of stabbing pain as he lies in bed on right side; and also shortness of breath on slight exertion.

Medical Report, Dec. 30.—Slight difference between two sides of chest; left side is less full as seen from front or back, and circumference is an inch less on left side. Stomach note reaches rather high in axilla; vocal fremitus and air entry lessened at left base. These signs point to slight collapse of left lung at base rather than to fluid, and I associate this with the pain leading the patient instinctively to spare the left side.

X-ray Report, Dec. 14, 1917.—Large metal fragment in left lower lobe 2½ inches from the X mark on posterior surface, marked also laterally and anteriorly. Some opacity of lower lobe. The metal moves slightly upwards and downwards on respiration.

Operation, Jan. 21, 1918.—Third left rib reflected in front. Filmy adhesions of upper lobe; firm adhesions of lower lobe to posterior wall. These were separated, and foreign body found in lung, and much fibrous tissue between lung and pleura. Removed; rib replaced; pleura stitched; pectoral muscle sutured; pectoral fascia stitched with thin catgut; continuous catgut for the skin; ether vapour and aspiration after closing the wound. Uninterrupted recovery.

Report, Dec. 5, 1919.—"I can say that I am feeling well."

Case 15.—**Foreign body in left lower lobe. Removal.**

P. S. Dvr. Admitted Dec. 10, 1917; discharged March 6, 1918.

Wounded Nov. 24, 1917. Gunshot wound of left chest and right hand (ring finger amputated); chest wound just below nipple; excised in France. No hæmoptysis, but painful, short breathing, and cough. Now complains of a stabbing pain on taking a deep breath; slight shortness of breath on exertion.

Medical Report.—Movements of chest equal and weak; semicircumference ½ inch less on left than on right side; vocal fremitus slightly lessened at left base; breath-sounds and vocal resonance slightly lessened, but percussion note equal; no cardiac displacement. *X*-ray showed irregular piece of metal, size of nail of ring finger, in left lung; freely movable.

Operation, Jan. 28, 1918.—Fourth left rib reflected with strip of periosteum; pleura incised vertically; adhesions of old operation prevented adequate stripping of periosteum from under surface of 5th rib; lobes of lung slightly adherent to each other. Piece of metal felt in upper part of lower lobe; this lobe was brought up and fixed with stay stitches. Foreign body removed by incising on to it. Lung stitched up with catgut, and dropped back; pleura did not come together at all nicely. Rib replaced, and costal cartilage held together by a stitch; continuous catgut skin stitch. Convalescence uninterrupted.

Report, Dec. 5, 1919.—"All that I can say with regard to my subsequent history since you operated on me in January, 1918, is, that I have felt extremely well."

Seen on Dec. 29, 1919. He was returned to duty, classed A1, in July, 1918, and remained in full work until March, 1919, when he was demobilized, condition perfect in all respects; rib quite sound.

Case 16.—**Foreign body in right lower lobe. Removal.**

S. W. M., age 22. Admitted Dec. 14, 1917; discharged Mar. 10, 1918.

Wounded Nov. 30, 1917, through the right upper arm and chest, the latter being entered just below the axilla. No hæmoptysis; very short of breath, and breathing difficult and painful; cough at times; severe stabbing pain on deep breathing and on exertion.

Medical Report, Dec. 26, 1917.—Movements equal on the two sides; some dullness at right base and right infra-axillary region; vocal fremitus and breath-sounds lessened over dull area. Probably these signs mean slight effusion with slight collapse of lung.

Operation, Jan. 28. 1918.—Incision in the line of 4th right rib in front. Rib reflected with periosteum attached, after dividing costal cartilage obliquely; pleura incised vertically; adhesions of lung to inner side of rib (about 8th) where foreign body was lying. Rib felt as though it had been fractured; foreign body removed; pleura stitched, but came together scarcely at all; rib stitched back into position; continuous catgut skin stitch.

Report, Dec. 7, 1919.—"I must say that as far as the operation is concerned the only time that affects me is when I get a cold on my chest, which causes a cough, and then too much coughing causes a slight pain where the incision was made. Pension 11/–."

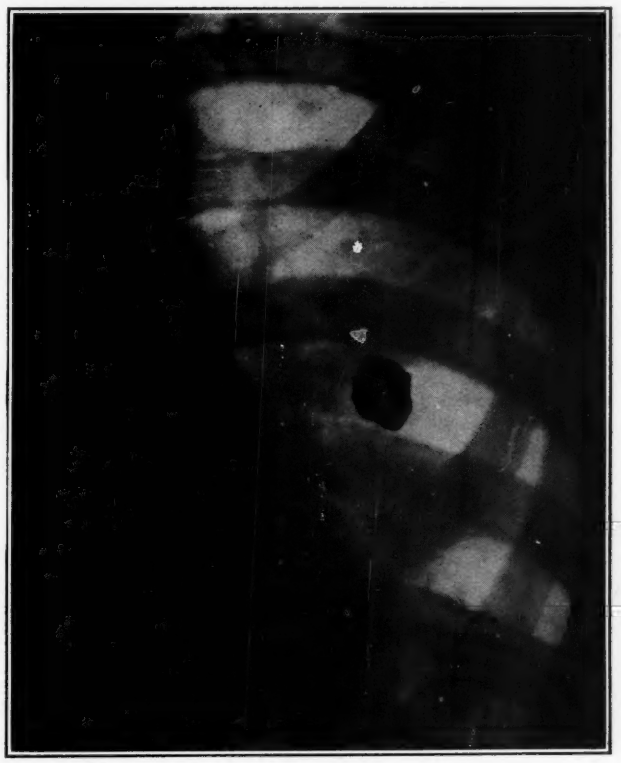

FIG. 396.—*Case* 17. Deformed shrapnel ball close to hilum of lung. Good recovery.

Case 17.—**Shrapnel ball in chest. Removal.**

E. W., age 21. Cpl. Admitted Dec. 27, 1917; discharged Mar. 10, 1918.

Wounded in left axilla Sept. 9, 1917. Empyema on this side drained in France. Previous to this had hæmoptysis for one day, cough, short and painful breathing; the cough has persisted off and on ever since. No pain now, and no shortness of breath. Two open wounds discharging freely.

Medical Report, Dec. 28, 1917.—General diminution in size of left side of chest, with lessened movements; both wounds are discharging. The physical signs do not point to the collection of any large quantity of matter.

Operation, Jan. 26, 1918.—Third left rib reflected; deformed shrapnel ball removed from thickened tissue just beneath rib (*Fig.* 396); pleura not opened; rib replaced; continuous catgut skin stitch; uninterrupted recovery; all wounds soon healed.

Report, Dec. 9, 1919.—"I have had no trouble with my chest at all, save just a cold or two."

Case 18.—**Shrapnel ball free in right pleural cavity. Removal.**

W. B., age 24. Admitted Dec. 31, 1917; discharged Feb. 25, 1918.

Wounded by shrapnel ball in upper part of right chest behind, Nov. 27, 1917. Hæmoptysis for three days, but not severe; short of breath for fourteen days, even while lying still. Complains of nothing now except some shortness of breath on exertion. No medical report before operation. An *x*-ray report states that there is a shrapnel ball which can be seen to roll about in the pleural cavity.

Operation, Jan. 4, 1918.—Third right rib reflected; shrapnel ball removed from the pleural

cavity; rib replaced and wound stitched up as usual; no pleural adhesions; no ether or aspiration; uneventful recovery.

Report, Dec. 6, 1919.—"Has gone to America. Good condition. Pension 8/–."

Case 19.—**Foreign body in right lower lobe. Removal.**

W. B., age 21. Admitted Jan. 15, 1918; discharged June 24.

Wounded June, 1917. Gunshot wound of right chest. Hæmoptysis and cough for fourteen days, with short and painful breathing; empyema developed, and was drained twice; last tube taken out about one month ago; wound burst open and discharged three weeks ago; stopped discharging three days ago. Complains of stabbing pain in both sides of chest, especially at night. Has some cough, and great dyspnœa on exertion.

Medical Report, Feb. 3, 1918.—Chest wall well formed, not so full on right side as left; semi-circumference at level of 1 inch below nipple, right 17 inches, left practically the same; the right infraclavicular region not so full as left. Movements over right side (whole of it) markedly impaired. Percussion: slight lessening of resonance over right upper part of chest in front; behind, note equal until lower part reached, where dullness on right side exists; vocal fremitus more marked on right side everywhere than on left (physiological); this is the case even at the right base; entry of air not so good on right side; no displacement of heart. These signs are quite compatible with imperfect basal expansion after drainage of empyema. and with some condensation towards apex of right lung; a few râles can be heard.

Operation, May 17.—Third right rib reflected; all lung densely adherent, so that there was no pleural cavity at all. These adhesions were separated, and the foreign body was felt in the lung on the posterior surface, which was brought uppermost; lung incised and the foreign body extracted; lung stitched; much bleeding from the raw surface, but this was stopped by pressure. Wound stitched up as usual.

May 20. Half pint of blood-stained fluid aspirated; otherwise convalescence uninterrupted.

Report, Dec. 7, 1919.—"I can play a good hour's Rugby with the best, but that rib you sprung in my chest generally gets in the way of someone's fist. If you had not taken that shrapnel out I would have been in cold storage now. I dare let you chop me up like oxo cubes, as I believe you would put me together again."

Case 20.—**Foreign body in root of left lung. Removal.**

F. L., age 20. Admitted Jan. 27, 1918; discharged April 15.

Wounded Dec. 5, 1917, in back of left chest below scapula. Hæmoptysis for about fourteen days, and cough, with short, painful breathing.

Dec. 7.—Two pints of fresh blood aspirated; now complains of stabbing pain in left side on exertion; no shortness of breath as he lies in bed; has not been up at all; no cough; wound healed.

Medical Report, Feb. 10, 1918.—Chest semicircumference, right side 18 inches; left 17 inches; movements impaired on left side. Percussion note: hyper-resonant at left base (in front); elsewhere on left side note impaired amounting to definite dullness at base behind; note impaired at right base behind; vocal fremitus only slightly lessened on right side; breath-sounds impaired at left base, no displacement of heart; cardiac sounds normal; chest looks flatter on left side. Heart position normal; breath, sounds very faint over left chest; some dullness; vocal fremitus present, but much less than on the right side.

X Ray Report.—Large foreign body in hilum of left lung at about level of 2nd costal cartilage.

Operation, Feb. 23.—Third left rib reflected; cavity opened containing 1½ pints of old blood; lung covered by thick layer of fibrin, which effectually prevented it from expanding. A very thick membrane compressed the lung and shut off the fluid-containing cavity. This membrane was removed almost entire; the lung then expanded. In root of lower lobe the projectile was felt; difficult at first to distinguish from a large bronchus. The lower lobe was drawn up into the wound, and the hilum incised. Foreign body removed, and hilum sutured by interrupted catgut stitches. Uneventful convalescence; returned to duty; discharged from Army, 1919.

Report, Dec. 13, 1919.—"Have every reason to think the operation a complete success, and am confident it will not handicap me in the future. I know my life was saved by it."

Case 21.—**Foreign body in chest; old hæmothorax. Empyema. Drainage.**

C. C., age 21. Admitted Jan. 30, 1918; discharged May 25.

Wounded Sept. 22, 1917, in left chest just below axilla in mid-axillary line; no hæmoptysis at the time, but very painful and difficult breathing; blood-stained fluid drawn off on three occasions; now complains of shortness of breath, but no pain, some cough and bleeding.

Medical Report, Feb. 3, 1918.—Chest well formed, but not so full on left side as right. Semi-circumference (8½ inches below nipple), left 17 inches, right 18 inches; movement much impaired on left side. Percussion: stomach note reaches high on left side; note higher pitched at left apex than at right, but quite good below this until stomach note reached; behind, note greatly impaired at the apex, and nowhere so good on left side. Vocal fremitus much greater at left apex in front than at right; posteriorly less at left apex than at right; equal at bases. Entry of air is poor everywhere on left side; no cardiac displacement. Clearly some collapse of lung (left), with drawing up of stomach; the collapse being least marked over lower lobe in front.

Operation, March 1.—Third left rib reflected; it was so firmly held to the pleura that the rib was fractured. The front part of the lobe of the lung was lightly adherent to pleura and pericardium; these were separated; behind and to the outer side was a cavity holding about 1 pint of old blood and some semipurulent material, and the foreign body (loose). The curtain dividing the two parts was like thick (¼ inch) wash-leather. Most of this was removed; lung so freed as to be practically brought outside; wound stitched up as usual; no drain.

Bacteriological Report.—Culture shows a coliform bacillus and *Streptococcus brevis.*

Up to Mar. 14, temperature, pulse, and respiration were normal; all began to rise then.

Mar. 21.—Large quantity of blood-stained, rather offensive fluid evacuated by removing a piece of 8th rib behind; drainage tube left in. As there was a small amount of a similar kind of fluid coming from wound, this was opened. Carrel's tube. Convalescence from this point uneventful.

Report, Dec. 8, 1919.—"I have been before several doctors, and they think it wonderful I look so well. I am a postman, and work on my rounds for six hours a day."

Case 22.—**Foreign body in root of left lung. Removal. Hæmorrhage. Death.**

J. B., age 30. Pte. Admitted Feb. 20, 1918; died Mar. 2.

Wounded Dec. 23, 1917, behind left shoulder; no hæmoptysis; but cough, and short painful breathing. Had massive dullness in France due to hæmothorax, proved by needling; said to be clearing rapidly on leaving France. Now complains of pain in left side on taking a deep breath; also very short of breath on exertion; some cough, no expectoration.

X-ray Report, Feb. 23, 1918.—Small piece of metal 4 inches deep below X mark on anterior surface over 4th rib, in the lower lobe; moves upwards and downwards on respiration, and there is a slight transmitted movement from the heart; considerable opacity over left lower lobe seen on screening; no evidence of fracture of rib in wound area.

Medical Examination, Feb. 24.—Movements lessened on left side at lower part; the sinking of intercostal spaces less marked on inspiration; left semicircumference of chest at nipple line is 16 inches on left side and 17 inches on right; note rather impaired at left base; vocal fremitus also lessened and breath-sounds lessened there; heart signs negative.

Operation, March 1.—Third left rib reflected; many light adhesions in front, and rather denser ones behind. These were separated. Lung freed; foreign body felt in part of upper lobe just at the hilum; removed by incision and then stitched; wound sutured as usual. There was *much bleeding from the lung during operation.* Patient died early next morning, having been in great distress with his breathing,

Post mortem.—Chest found full of blood.

Case 23.—**Foreign body in pericardium, adherent to the heart. Removal.**

R. L., age 25. Pensioner. Admitted March 15, 1918; discharged May 11.

Wounded Sept. 24, 1915.

X-ray Report, March 3, 1918.—A shrapnel ball lying 3⅝ inches below X mark on anterior chest wall to right of middle line; it moves with the heart beat. When viewed anteroposteriorly, there is a horizontal and transverse movement; and laterally the movement is anteroposterior. The metal moves downwards with the heart on inspiration; is apparently within or attached to pericardium. Right lower lobe shows much patchy opacity over a considerable area around metal, very suggestive of thickening of pleura and possibly adhesions to pericardium.

Operation, April 18.—Fifth right rib reflected; pleura opened. Some adhesions, especially behind; lobe of lung peeled off pericardium, and attached to this by dense fibrous tissue the ball could be felt and seen; fibrous tissue cut through and ball removed. Wound stitched up as usual; pleura came together better in this case than is the custom at a higher level.

Report, Dec. 16, 1919.—"Since my operation I can assuredly say I have been very well; the scar gives me no trouble, and I can never, like others with such scars, feel the change of the weather. Sir, you can take it for granted that since that most wonderful operation I have felt better and easier in my mind."

I have seen this man several times. He is doing all his old work as well as ever.

Case 24.—**Foreign body in right lower lobe. Removal.**

E. W., age 32. Admitted March 25, 1918; discharged June 24.

Wounded Oct., 1914, in back of right chest; had hæmoptysis more or less for five months; also cough and short painful breathing; no empyema. Now complains of shortness of breath and pain in right side after walking; these attacks come on periodically under ordinary circumstances; but if he exerts himself more than usual a very severe attack comes on at once. Hæmoptysis off and on since original attack ceased; many severe chills like influenza.

X-ray Report, March 28, 1918.—A fragment of shrapnel 2½ inches deep from X mark on posterior surface of chest wall over 9th rib, below and internal to inferior angle of scapula, in right lower lobe; moves quite freely upwards and downwards on respiration. The lung appears normal. There has been a comminuted fracture of 7th rib above the metal.

Medical Report, April 4.—Chest wall well formed and symmetrical; semicircumferences equal; movements equal on the two sides; breath-sounds equal on the two sides; no physical signs.

Operation, April 18.—Fourth right rib reflected; pleura opened. One fairly firm adhesion

divided in front, and many behind. Foreign body felt on inner side of lower lobe; this side was made to present, and the lung drawn up by sutures. The foreign body was exposed by cutting through about half an inch of lung tissue; stitched up again after removing shrapnel. Wound closed in usual way.

April 30.—One pint of blood-stained fluid aspirated from lower part of right chest; no temperature, or disturbance of any kind; aspiration done to relieve slight respiratory difficulty and dullness. Convalescence otherwise uneventful.

Case 25.—**Foreign body impacted in vertebra. Not removed.**

R. B., age 29. Cpl. Admitted April 17, 1918; discharged June 17.

Wounded March 27, 1918. The missile entered below middle of right clavicle; had hæmoptysis for six or seven days; also cough and shortness of breath. Slight cough now, and pain over sternal region when he coughs, and on exertion; some shortness of breath still persists.

Medical Report, April 22, 1918.—Chest well formed. On careful inspection the movement is slightly impaired at right base; semicircumferences are equal, however. At right base there is very slight impairment of resonance; physical signs are negative in other respects.

Operation, May 3.—Second right rib reflected in usual way; the amount of room obtained was distinctly less than after reflecting 3rd and 4th ribs. The upper lobe of right lung was fairly adherent on all its aspects. After separating adhesions—the foreign body sticking through from behind in the region of the transverse processes—the exact position was rather difficult to make out; but the missile was so firmly fixed that a hammer and chisel would have been required to move it. Wound stitched up as usual. No ether used; uneventful recovery.

Case 26.—**Shrapnel ball in heart. Removal.**

J. B., age 34. Admitted April 13, 1918; discharged June 29.

Wounded April 11, 1917, in France. Gunshot wound of left chest in mid-axillary line; had short painful breathing and some cough; does not remember any hæmoptysis. Empyema opened behind about nine days after wound, and continued to discharge until November. Original wound still discharging slightly; foreign body still in. Now complains of much shortness of breath on exertion (particularly going upstairs); no pain or cough; deficient air entry at left base.

Medical Report, April 22, 1918.—Left semicircumference 1 in. below nipple is nearly 1 in. less than right. Slight dullness at left base, with diminished vocal fremitus; air entry pretty good; lung evidently not fully re-expanded.

X-ray Report.—Shrapnel ball in heart, between left auricle and ventricle.

Operation, May 3.—Third left rib reflected; after some search the shrapnel was felt through the pericardium. The pericardium was opened, and the bullet found to be imbedded in heart at base of left ventricle, just below auriculo-ventricular groove. Two stitches were put into the heart, one on each side of foreign body, and an incision made between them down to bullet, which was lifted out of a little cavity with a scoop. Two stitches closed cavity in heart muscle, after application of pure carbolic acid. Recovery speedy and without incident; patient kept very quiet for six weeks, to rest heart.

Report, Dec. 4, 1919.—"I am not yet capable of doing my usual work."

Case 27.—**Foreign body in right lower lobe. Removal.**

F. O., age 20. Admitted March 27, 1918; discharged July 29.

Wounded March 12, 1918, in right shoulder above scapula. Hæmoptysis for three days, cough and shortness of breath; wound has discharged ever since. Slight shortness of breath and some pain now, but very little, I think.

X-ray Report, April 17, 1918.—A piece of metal 1½ inches deep from X mark on posterior chest wall; moves downwards on inspiration. Slight opacity over right lower lobe (? due to adhesions). The metal is in the posterior part of right lower lobe close to pleura. There is, I think, necrosis of vertebral border of scapula.

Medical Report, April 22.—Chest not quite symmetrical, there being slight deviation of spine; movement slightly impaired at right base, where also the note is less resonant than on the other side. Vocal fremitus everywhere slightly greater on right side than left; this, of course, is a normal condition, but my point is that even over the dull area it exists, and probably there is some diminished air entry in lower lobe of right lung.

Operation, June 8.—Fourth right rib reflected; lung adherent behind over a surface about the size of the palm of one's hand; otherwise pleural cavity free. Foreign body removed from posterior aspect of lung, quite superficial, after separating adhesions (about level of 8th rib). Rib replaced, and wound stitched as usual. Foreign body sterile after forty-eight hours' incubation.

June 12.—Several ounces of blood-stained fluid aspirated; rather stormy convalescence for first ten days; all right after.

Report, Dec. 15, 1919.—Doctor reports that "the expansion of right lung is 1 inch less than left." The patient writes: "I have had very little trouble with my chest; sometimes when I lean over to the right side I have a dull pain about my ribs; otherwise the operation has been very good."

Case 28.—**Rifle bullet in pericardium, adherent to heart.**

W. W., age 37. Gunner. Admitted May 22, 1918; discharged July 29.

Gunshot wound of left chest 1½ inches internal to nipple. Wounded April 9, 1918; had hæmoptysis for fourteen days, with cough, and short painful breathing; now complains of pain on left side on exertion, and when lying on left side; says originates in chest (left), also shoots into neck; no cough.

X-ray Report, April 24, 1918.—There is a rifle or machine-gun bullet lying 1⅞ inches deep from X mark on anterior surface over 5th rib, and about 1½ inches from lateral border of sternum (*Fig.* 397). Slight downward movement on inspiration, but not to ths same extent as diaphragm. It is felt above diaphragm—but only slightly. Also slight movement in transverse direction due to cardiac beat. I think the bullet is in left lower lobe close to apex of heart. Slight opacity of tissues around bullet.

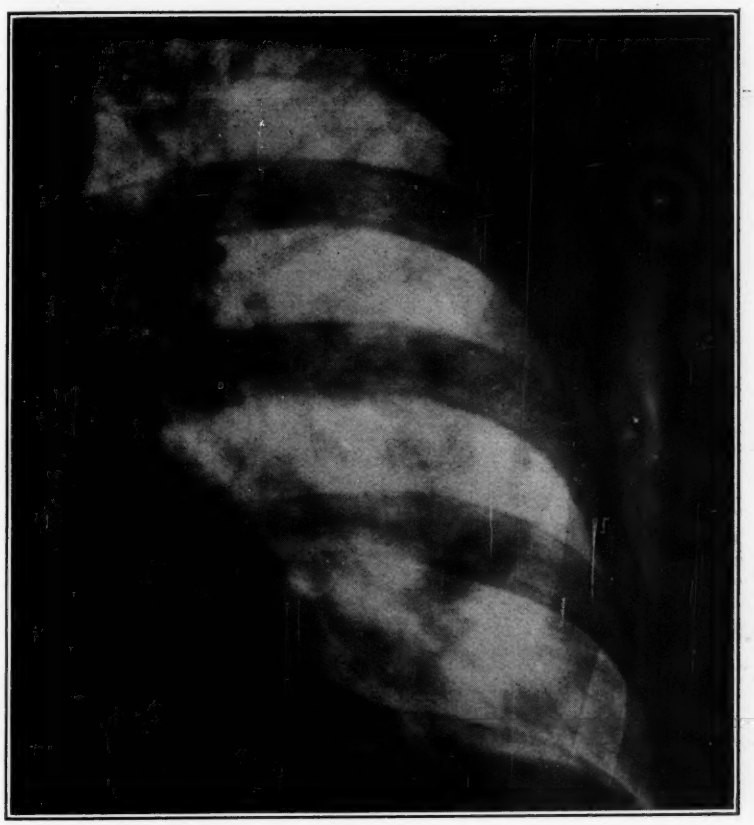

FIG. 397.—*Case* 28. Bullet in pericardium adherent to the heart. Much patchy opacity of lung. Many adhesions of pleura. Recovery. Patient now working as a miner.

Medical Report, May 26.—Semicircumference rather more than 18 inches on right side, rather less than 17 inches on left side. Some diminution in size of left side of chest generally, more noticeable from front; no definite alteration in percussion note, and I think not more than the physiological difference of vocal fremitus on the two sides. The left lung is clearly, therefore, less voluminous than the right.

Operation, June 8.—Fifth rib (left) reflected and bullet removed from surface of heart; lung had to be peeled off, and bullet was found embedded in fatty fibrous tissue to left of apex; it was not in the heart substance, but adherent to it, and to the pericardium, which was very thick; there was about ½ dr. of pus around bullet cavity; this was swabbed out with pure carbolic, and the wound stitched up as usual. Foreign body sterile after forty-eight hours' incubation.

Case 29.—**Shrapnel ball in right lower lobe. Removal. Speedy recovery. Pericarditis later.**

J. S., age 22. Pensioner. Admitted June 10, 1918; discharged Aug. 14.

Wounded May 3, 1915, by a shrapnel ball entering in mid-axillary line opposite 6th right rib,

Had short difficult breathing, but no hæmoptysis ; the wound is healed. Patient twitches occasionally, and has been treated for neurasthenia ; also has fits in which he falls (but never hurts himself), foams at mouth, and bites his tongue ; the last fit was ten weeks ago. Complains, so far as chest is concerned, of shortness of breath on exertion and some pain in back.

X-ray Report, June 6, 1918.—A shrapnel ball, 1¾ inches deep from the X mark over 11th rib posteriorly ; moves quite freely on respiration ; can be seen, when viewed laterally on the screen, to be between diaphragm and chest wall ; is either in, or attached to, lower border of right lower lobe, practically touching the parietal pleura. The lung tissue appears to be quite normal ; there are no signs of adhesions.

Operation, June 14.—Fifth right rib reflected. Pleural cavity not obliterated, but some light and some very firm adhesions found, and divided ; these adhesions were uniting the lower lobe to the parietal pleura ; bullet lay in the lower lobe, and was removed ; two stitches inserted ; wound closed as usual ; no growth obtained from bullet after forty-eight hours' incubation. Patient had a very stormy convalescence, developing pericarditis about ten days after operation.

Medical Report, June 25.—Some dyspnœa—respirations 32. Movements on the right side of chest impaired, lower lateral intercostal spaces filled up (part of this is due, of course, to surface swelling and hæmorrhage). Apex beat to left (5th space, a good inch beyond nipple line). All over precordial area to left of sternum a well-marked precordial friction sound heard. Respiratory movements lessened on right side ; marked dullness of right base, with diminished vocal fremitus ; breath-sounds lessened. These signs, of course, point strongly to fluid in chest.

June 28.—Half-pint of blood-stained fluid drawn off.

July 10.—Very much better, though slightly short of breath, especially after exertion. Still an exceedingly loud and rough friction-sound of cardiac rhythm, loudest precisely over apex beat, which is either pericarditis or a local pleurisy in which the friction sound is developed by the movements of heart. Doubtless the wide distribution of the friction sound heard on June 25, and which extended beyond the lappet of lung which covers the heart, points to true pericarditis. Slow recovery after this date.

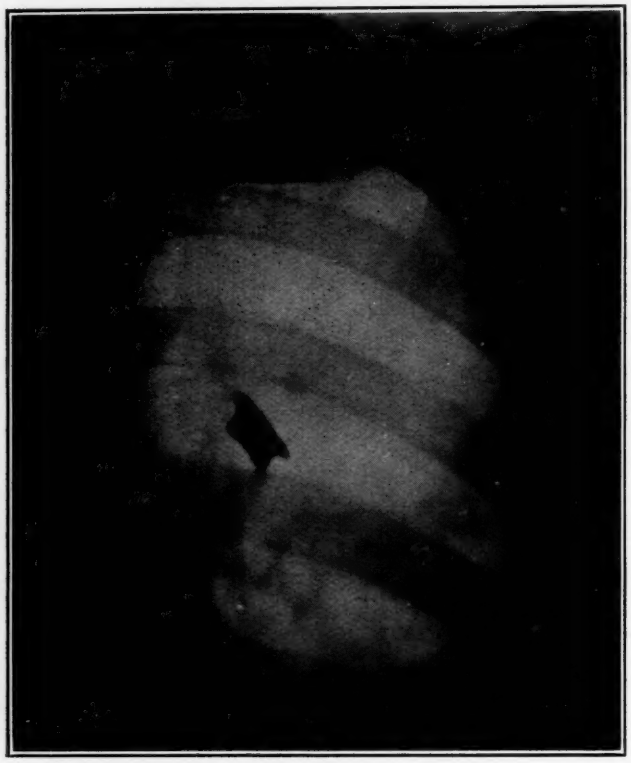

FIG. 398.—*Case* 30. Fragment of shell in hilum of lung. Removal. Hæmorrhage arrested by saline. Good recovery.

Report, June 14, 1919.—"Being just a twelvemonth ago since I was operated upon by you I feel it my duty to write to you. Sir, I have felt extraordinarily well, and I am getting on very well."

Dec. 4.—"I am almost in the best of health."

Case 30. — **Foreign body in root of left lung. Removal.**

F. P., age 30. Pte. Admitted July 5, 1918 ; discharged Sept. 20.

Gunshot wound left shoulder ; comminuted fracture of humerus ; passed on into lung. Wounded June 1, 1918 ; had hæmoptysis for one week, with short painful breathing ; now complains of pain in left side, and shortness of breath on exertion. Humerus united in good position, with good movement.

Medical Report, July 28, 1918.—Left side of chest 2 inches less than right ; expansion lessened ; no cardiac displacement ; slight impairment of note at left base, and diminished air entry.

X-ray Report.—Comminuted fracture of surgical neck of humerus ; small fragment also broken off lower margin of glenoid ; both in good position ; fragment of metal in hilum of left lung (*Fig.* 398).

Operation, Aug. 9.—Third left rib reflected (accidentally fractured 3 inches from sternal margin) ; many adhesions, which bled freely, but stopped easily on pressure ; foreign body removed from root of lung. A pair of forceps was pushed gently towards foreign body, which was distinguished with some difficulty from bronchus close to it. A 'niggling,' scratching movement made with

forceps till the metal was felt and grasped; then gentle withdrawal. Rib replaced; wound stitched up as usual.

Aug. 14.—Twenty ounces of blood-stained fluid aspirated. Convalescence smooth.

Report, Dec. 4, 1919.—"I have made steady progress all the time since my operation, and my breathing, although not quite normal, is comparatively good."

Case 31.—**Rifle bullet in lower lobe of right lung. Removal.**

J. McG., age 28. Pensioner. Admitted Aug. 22, 1918.

Gunshot wound of right chest; entrance at lower part of right axillary fold.

Wounded Sept. 26, 1915; had short painful breathing at time of injury, and hæmoptysis, which he has since had off and on until one year ago; now complains of pain in chest and shortness of breath on exertion.

X-ray Report, Aug. 26, 1918.—A rifle or machine-gun bullet in upper part of right lower lobe (*Fig.* 399), 3½ inches deep from the X mark on posterior surface and about 6 inches from anterior. The bullet moves quite freely upwards and downwards on respiration; there is slight patchy opacity of right lower and middle lobes, but from the freedom of movement I think there cannot be many adhesions.

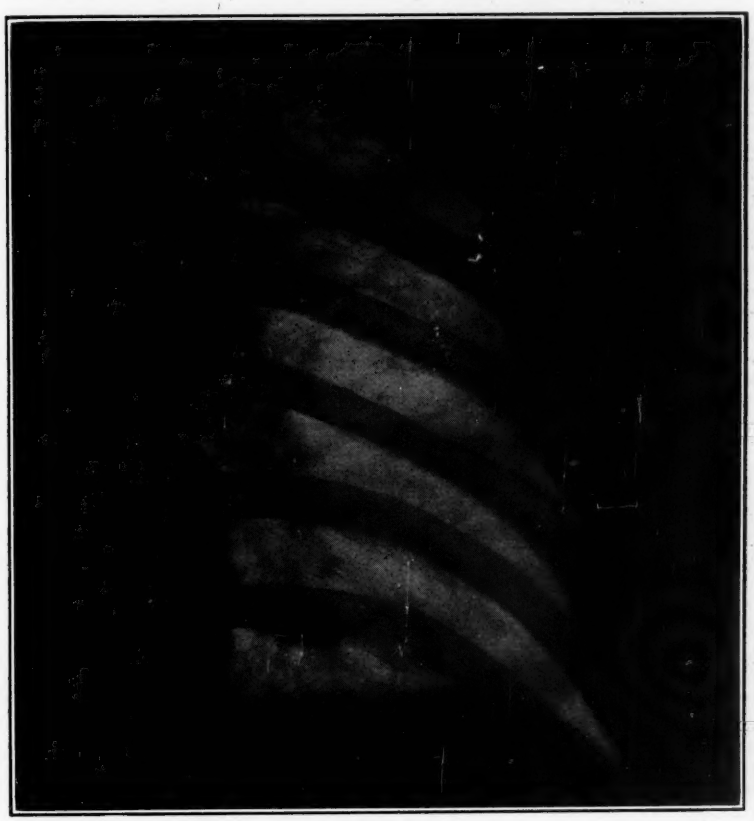

FIG. 399.—*Case* 31. Machine-gun bullet removed from right lower lobe very close to hilum. Lung everywhere adherent. Good recovery.

Medical Report, Aug. 27.—Physical examination negative.

Operation, Sept. 3.—Oxygen and ether. Fourth right rib reflected; lung universally adherent: in front by adhesions which were easily separated, behind by very dense ones. Foreign body close to root of lung, and only removed after freeing the lobe, and then with great difficulty. Free bleeding, stopped by sutures; wound stitched up in usual way. Foreign body infected: *Staphylococcus aureus* and coliform bacilli.

Oct. 7.—Began coughing yesterday, and bringing up sputum, with some pain in side (right); there is not full expansion, especially in front and above; tubular breathing in the axilla.

Oct. 9.—Right chest explored—about ½ oz. of straw-coloured fluid drawn off.

Oct. 11.—Explored again. Four ounces of same kind of fluid found by puncture at outer end of wound; culture sterile; no tubercle bacilli found.

Oct. 12.—This is a purulent fluid—no organisms found in smear.
Oct. 29.—Chest again explored; fluid blood-stained; abundant pus cells; culture sterile.
Nov. 2.—Front wound drained; purulent fluid.
Feb., 1919.—Wound healed; very little expansion of lung, or air entry.
Report, Dec. 4.—"I do not think I can thank you enough for what you did for me. I have a trying time in the cold weather. I am off the doctor's books, but I do not think I shall ever be the man I was before the war."

Case 32.—**Foreign body in upper lobe of left lung. Removal. Staphylococcus aureus infection. Empyema. Drainage. Death.**

J. S., age 21. Admitted Aug. 30, 1918; died Oct. 12.
Gunshot wound of left chest; entering below outer end of clavicle. Wounded Dec., 1915, in Serbia; had hæmoptysis for one month, with short and painful breathing; has been back to France, but could not carry on owing to pain and shortness of breath on exertion.
Medical Report, Sept., 1918.—Chest normal; physical signs negative.
X-ray Report, Oct. 2.—A metal fragment 3½ inches deep from X mark on anterior surface over 3rd left interspace; slight movement downwards on inspiration; also slight transmitted movement from heart; lung shows very slight patchy opacity. I think the metal is in left upper lobe close to root.
Operation, Oct. 4.—Fourth left rib reflected; no pleural cavity; adhesions particularly dense over upper lobe; foreign body felt in upper lobe nearer anterior than posterior surface; adhesions were freely separated, reproducing a pleural cavity; free bleeding, but easily stopped with hot swabs. The foreign body was removed by incising lung from outer aspect, and after removal two stitches were inserted; wound closed as usual. A piece of cloth found on projectile.
Culture from foreign body gave a *pure and abundant growth of Staphylococcus aureus.*
Oct. 5.—Emphysema noticed, extending around wound and down left arm as far as wrist. Patient spits small quantities of fresh blood; very short of breath.
Oct. 7.—Emphysema less, but breathing still very difficult. Two ounces of bloody fluid aspirated. Microscopically, much blood with cocci clumps. Culture: prolific growth of *Staphylococcus aureus.*
Oct. 9.—One pint of fluid, as before, aspirated.
Oct. 11.—Some hypostatic congestion in right lung; no tubercle bacilli in sputum; pus, 7 organisms present.
Oct. 12.—Left chest drained without removing any rib; 1 pint of dirty blood-stained fluid removed; tube left in.
Death soon after operation.

Case 33.—**Foreign body in left lower lobe. Removal.**

R. D., age 22. Pensioner. Admitted Oct. 1, 1918; discharged Oct. 24.
Gunshot wound of left chest in front, over 2nd rib; also an operation scar through which a piece of shrapnel had been removed (? depth); all wounds healed.
Wounded Aug. 5, 1915; had hæmoptysis for about fourteen days, and short painful and difficult breathing; no mention of hæmothorax or effusion; now complains of pain of a stabbing nature in left chest, particularly on exertion; also shortness of breath when moving about much; cough intermittent and 'teasing.'
X-ray Report, Oct. 3, 1918.—There is a foreign body in left lower lobe, close to anterior chest wall and ¾ inch from left border of left ventricle. There is downward movement of the metal on inspiration, also transmitted cardiac impulse; opacity over left lower lobe, and left arch of diaphragm moves less than it should.
Medical Report, Oct. 4.—The left semicircumference of chest fully 1 inch less than right; the note slightly impaired on left side (more especially in front, I think), and the vocal fremitus and vocal resonance, as well as the breath-sounds, distinctly less on left side.
Operation, Oct. 4.—Oxygen and ether. The 4th left rib was reflected with a periosteal bridge; no adhesions were found in pleural cavity; lung quite healthy. A small piece of shrapnel was removed from anterior edge of lung, and the part stitched up with two catgut sutures; rib replaced, and wound stitched up as usual; healed perfectly. No respiratory or other difficulties after operation.
Report, Dec. 9, 1919.—"I am a coal miner, and consider myself a fortunate man in being able to follow this laborious work."

Case 34.—**Rifle bullet in lower lobe of right lung. Removal.**

T. A. W., age 19. Rfm. Admitted Nov. 1, 1918; discharged March, 1919.
Gunshot wound of right chest and right arm, Aug. 27, 1918. The missile travelled from the insertion of deltoid upwards and inwards, leaving arm on inner side just below hairy axilla, and entered chest immediately opposite. The arm wound is practically healed; still a little weakness of fingers. The wound in the axilla is small, but discharging. Never had any hæmoptysis, but considerable difficulty in breathing; now complains of very little beyond shortness of breath on going upstairs, and occasional stabbing pain in chest.

X-ray Report, Nov. 4, 1918.—A bullet in right lower lobe; 2½ inches from the X mark on posterior surface; on the level of the nipple line on right side; no movement on respiration. Much opacity of lower and middle right lobes, and absolute fixation of right arch of diaphragm.

Medical Report, Dec. 6.—Right side of chest is ½ inch less than left. Inspection from front shows right side is not so full as left—nipple appearing a little lower on left. Expansion is lessened on right side as seen from front; some impairment of percussion note in right axillary and subaxillary region; also breath-sounds impaired. Great increase of myotatic irritability of pectoral muscle of right side.

Operation, Feb. 21, 1919.—Oxygen and ether. About 3 inches of 7th right rib removed behind. During operation rib was merely reflected upwards and forwards, but it was decided to remove it finally, in case it should project into pleura. The posterior route was chosen as the sinus in axilla would have been dangerously near operation wound. Some filmy adhesions were separated; one strong hand-like prolongation of the lower lobe was firmly fixed to chest wall, and at this point the bullet was felt—near the diaphragmatic reflection. This muscle was moving freely. Wound stitched up; pleura came together hardly at all—much worse than the front wounds. Small tube left in, it being felt that emphysema would occur as pleura was so poorly united.

Feb. 22.—Tube removed; considerable amount of blood-stained serum came away (soaking dressing), though at operation there was practically no bleeding. Patient absolutely comfortable—no respiratory distress or increase in frequency; pulse and temperature quiet. Expansion (active) of lung could be carried out from the first.

Report, Dec. 6.—"At present I am feeling very well. The bullet wound under my right arm still causes me trouble, but my chest is perfect."

Case 35.—**Bullet in upper lobe of right lung. Removal.**

H. P., age 23. Sgt. Admitted Dec. 7, 1918; discharged Feb. 7, 1919.

Gunshot wound of back, about level of 3rd rib, in line of vertebral border of scapula. Wounded Oct. 17, 1918; had hæmoptysis on first day—short painful breathing for about one week; now has occasional cough (no sputum), and pain behind sternum; is short of breath on mounting stairs; physical signs normal.

Operation, Dec. 20, 1918.—Third right rib elevated; very slight adhesion at one part of upper lobe to anterior wall; lung palpated and bullet felt about 1 to 2 inches from hilum; lung held with special forceps and incised; bullet extracted. Four stitches inserted into lung; very slight bleeding, arrested by additional stitch; smooth convalescence.

Report, Dec. 28, 1919.—Feels better than before the operation in that he has no pain and is less short of breath. He has gained weight and feels perfectly well. He used to be a professional boxer, but he does not think he is well enough to go into training, and is "rather afraid of being hit on his wound." He has no complaint of any kind except that "he gets a little short of breath on much exertion."

Case 36.—**Foreign body in upper lobe of right lung. Removal.**

F. O., age 36. Pensioner. Admitted Dec. 28, 1918; discharged March, 1919.

Wounded July 1, 1916; entrance wound below centre of clavicle. He had short difficult and painful breathing, and hæmoptysis, from the first, and off and on since, though it has only been streaks of blood in the morning, as a rule. Now complains of losing weight, streaks of blood in sputum, and cough; stabbing pains in chest more or less all the time; has had to stop work in winter months owing to his cough and chills; never had anything like this before he was wounded.

X-ray Report, Jan. 1, 1919.—A fragment of metal in right chest, 3 inches deep from the X mark on posterior surface; also marked anteriorly and laterally; upward movement on inspiration, with chest wall. The metal is definitely in lung, and lung is bound down to chest wall; thickening (opacity) of lung around foreign body, and patchy opacity over lower lobe; diaphragm moves quite freely.

Medical Report, Jan. 9.—Movements equal on the two sides; expansion on right side at upper part very slightly impaired; no other abnormal signs.

Operation, Jan. 17.—Oxygen and ether. Third right rib elevated; later, fractured and removed. Lung excessively adherent, and a good deal of hæmorrhage while separation was being done. Scissors had to be used and lung sutured. The projectile, together with a piece of khaki cloth, lay in the part of the lung adherent to chest wall; wound stitched up as usual.

Jan. 19.—One pint of fluid, heavily stained with blood, aspirated.

Jan. 20.—Extensive surgical emphysema, puffing up the face and crepitating in both arms as far as wrists, and the abdominal wall as far as groins.

Jan. 26.—Half pint of straw-coloured fluid aspirated; a swab taken from foreign body grew scanty colonies of staphylococci and a few diplococci. Sputum examined before operation did not reveal any tubercle bacilli. Emphysema settled down in about ten days without any treatment.

March 1.—Examination of right chest shows good air entry, though not quite equal to other side.

Report, Dec. 4.—"I am pleased to tell you that I manage fairly well, though my chest troubles me a bit. My breathing is bad in the cold weather, but I have to work, as my pension is small. I have a cough in the morning just when I get up."

Case 37.—**Large foreign body in lower lobe of left lung. Removal.**

C. L., age 21. Pte. Admitted Jan. 27, 1919.

Gunshot wound of left chest, just below apex beat of heart. Wounded Oct. 25, 1918; entrance just below left costal margin in front; healed; never any hæmoptysis, but had short painful breathing for a few days. Two previous attempts to remove the shrapnel had been made before admission to this hospital; both were unsuccessful; now complains of pain in lower part of left chest, in front, when taking deep breath; no physical signs.

X-ray Report, Jan. 27, 1919.—A fragment of metal directly under the X mark; attached, I think, to posterior surface of 7th rib, 1 inch deep. No movement on respiration, and no sign of fracture of rib.

Operation, Feb. 12.—Oxygen and ether. A cube of shrapnel removed from lower lobe of left lung after reflecting 7th rib. It lay about ¼ inch deep in lung, and the latter required stitching afterwards. Very few adhesions of lung to costal cartilage; no respiratory or other difficulties after operation. Healed perfectly.

Report, Dec. 3.—"I am pleased to say that I have had no ill effects from the operation, excepting, of course, a little shortness of breath when hurrying, which makes me gasp."

Case 38.—**Foreign body between middle and lower lobes of right lung.**

W. B., age 34. Admitted Feb. 14, 1919; discharged July 14.

Wounded Sept. 19, 1916; entrance just below and to outer side of right coracoid process. Hæmoptysis for four days, at first very severe; then, and for several months after, short, difficult, painful respiration. Was aspirated several times; an empyema formed, which was drained behind; discharged for five months; has been healed up two years. Now complains of pain in right chest almost unceasing; worse on movement or on severe exertion; on taking a deep breath feels "as though something clutched his chest." Twice hæmoptysis; often getting chills and cold shivers, and feels ill for a few days; cough then very troublesome, and a good deal of expectoration.

Examination of Chest.—Left half 17½ inches; right half 16½ inches; expansion rather impaired on right side; percussion note impaired at right base; physiological excess of vocal fremitus on right side is not maintained. It is clear, therefore, that the lung is smaller at lower part than it should be, and contains less air.

X-ray Report, Feb. 17, 1919.—There is a large piece of metal in right chest, 4 inches deep from X mark on anterior surface over 4th rib; slight downward movement on inspiration; considerable opacity of right middle and lower lobes; partial fixation of diaphragm. The piece of metal is in middle of right lower lobe, and there are thick adhesions of right lower lobe.

Operation, March 3.—Fourth right rib reflected; pleural cavity was found entirely obliterated; the adhesions were especially firm behind, where rib had been removed; diaphragm also very adherent; cavity of pleura re-formed; much bleeding. Foreign body was found between middle and lower lobes close to hilum of lung. A pair of forceps scraped a way through to metal, which was gently removed; bleeding checked by two sutures; wound stitched up as usual. Owing to free bleeding a small tube was placed in chest behind and left two days.

Bacteriological Report.—Cultures showed a scanty growth of streptococci and staphylococci.

By March 17 it was evident that there was fluid in chest, accumulated since tube was removed; chest therefore opened behind and drained; Carrel-Dakin tubes introduced. Culture showed a growth of pneumococci. Condition rapidly improved after drainage; anterior wound healed normally; posterior wound was healed by June 21, and patient left hospital on July 14. *X*-ray examination showed a better range of movement in diaphragm and less opacity.

Nov.—Seen and examined. Excellent progress since operation; a little short of breath, but getting better every week.

Case 39.—**Large piece of shrapnel in left lower lobe. Removal by posterior incision.**

A. S., age 21. Admitted March 10, 1919; discharged July 10.

Wounded Aug. 31, 1918, by shell; severe hæmoptysis for two to three days. Operated on at Boulogne; rib resection and drainage of empyema on left side; healed up for three weeks in Jan., 1919, then broke down; healed again; broke down again; and healed up again a week ago. Occasional hæmoptysis, not very severe, until present time; great dyspnœa on exertion.

Physical Signs.—Scar in 2nd left space in front and over 8th rib behind; movement not nearly so good on left as on right side of chest; breath-sounds normal at apex, very poor elsewhere.

X-ray Report.—A large fragment of metal 2 inches deep from posterior surface; moves on respiration; much opacity of lower half of chest; part of 9th rib has been removed; movement of left arch of diaphragm very slight.

Operation, May 30.—Posterior incision; 4 inches of 9th rib removed. Foreign body lay in fibrous-feeling lung tissue. Removed. Owing to sepsis, wound was drained for four days. On July 10 sent to military hospital for disposal; wound healed; lung acting much better.

Bacteriological Report.—Foreign body sterile.

Case 40.—**Foreign body in right lower lobe of lung. Removal.**

C. F. A., age 23. Admitted April 10, 1919; discharged July 10.

Wounded Aug., 1918; hæmoptysis and shortness of breath since; wound of entry over 5th rib, right side, in front; has been healed; sinuses have formed around it when wound closed temporarily.

On Examination, April 12, 1919.—Right side of chest smaller than left, though expansion is good; note impaired over right chest behind, and breath-sounds not as well heard as on left side.

X-ray Report.—A small fragment of metal in right lower lobe of lung 3½ inches from opening of sinus in anterior chest wall; no movement on respiration; fixation of right arch of diaphragm; opacity of right lower lobe.

Operation, May 9.—Sinus excised, and 5th rib elevated; adhesions divided; lung pierced by forceps, and foreign body removed.

July 10.—Discharged with all wounds healed, better movement of chest wall and diaphragm.

Bacteriological Report.—Foreign body gave abundant growth of *Staphylococcus aureus* and a few coliform bacilli.

Report, Dec. 12.—"My wounds are totally healed and give rise to no trouble whatever. I suffer from shortness of breath, but nothing so bad as it was. The doctor says I still have some collapse of the lung."

Case 41.—**Foreign body in lower lobe of right lung. Removal.**

J. McG., age 30. Admitted April 10, 1919; discharged July 2.

Wounded by shell, July 17, 1916; hæmoptysis for two or three days. No operation or exploration performed; complains now of pain in right chest and hæmoptysis, which has occurred almost daily since wounded, in smaller or larger quantities; has small healed wound in posterior axillary line.

On Examination.—Breath-sounds feebler on right side than left; no other signs.

X-ray Report.—A fragment of metal, size of a small nut, in right middle lobe; it moves downwards on inspiration, but there is a certain amount of limitation of movement due to adhesions of lung. The foreign body is 4 inches deep from right nipple; there is slight patchy opacity of lower and middle lobes; no fixation of diaphragm.

Operation, April 30, 1919.—Right 4th rib reflected; foreign body felt in posterior portion of right middle lobe; very firm adhesions to posterior chest wall were separated, and lung turned so that posterior surface came out of wound; foreign body then removed; free bleeding, soon stopped by hot swab pressure; healed forthwith; movements of chest were free, and breath-sounds normal, on discharge.

Bacteriological Report.—The foreign body gives a prolific growth of *Staphylococcus aureus*, and a coliform bacillus.

Report, Dec. 5.—"I still feel the results of the operation, especially since the damp, foggy weather set in. I still have the pain in the chest, especially after coughing, and don't seem able to get rid of my cough. At times my breathing is somewhat difficult. The only work I have done since leaving hospital was four days as postman, and had to give that up, as I could not stick it on account of cycling, etc."

Case 42.—**Foreign body in upper lobe of right lung. Removal.**

W. M., age 20. Admitted July 7, 1919; discharged Sept. 20.

Wounded April 25, 1918, by shrapnel, which entered the outer aspect of arm just below head of humerus. Removed to hospital (in France, two weeks; in Tankerton, Kent, three weeks; and Shorncliffe, two weeks), where wound healed without suppuration. Discharged and returned to usual work—pony driving in the pit—at which he remained six months. This job, which means much bending work, caused pain of a pricking nature, which patient localized in front of chest in intercostal space; was rather short of breath when working hard, but not on ordinary exertion, such as walking about; no cough. On account of the pain patient came to work on the top, at plate-laying; was better here, though still occasionally bothered with pain and shortness of breath. Consulted his doctor for the 'pricking pain,' and was referred to the Leeds General Infirmary for treatment. Has never spat blood, and has not had a cough since discharge; his only complaint was the pricking pain in chest and shortness of breath on exertion.

X-ray Report.—A piece of metal in right chest; 3 inches deep from X mark on anterior surface, inner end of 1st interspace; moves very slightly downwards on inspiration. It is, I think, in the root of the lung, which appears to be normal.

Examination of Chest.—Semicircumferences of chest equal on both sides; expansion equal. The only difference between the two sides, and this open to doubt, is that the breath-sounds are not so full on right side. In reference to *x*-ray report, I think "3 inches deep from the X mark" would probably mean rather above the root of lung.

Operation, Aug. 22, 1919.—Third right rib elevated; pleura opened; numerous adhesions, easily broken down; metal lay in upper lobe of right lung very close to hilum; upper lobe was adherent on inner side; on separating adhesions the metal fell into the surgeon's hand. No sutures necessary; opening in lung looked smooth and clean.

Bacteriological Report.—No growth in aerobic or anaerobic media.

Healed immediately; discharged well on Sept. 20.

Case 43.—**Foreign body in lower lobe of left lung. Removal. Empyema.**

S. P., age 31. Admitted Aug. 25, 1919.

Wounded March 27, 1918, in shoulder (left), penetrating chest; coughed up blood at the time, but this ceased in twenty-four hours; aspirated at base hospital, and about 20 oz. blood withdrawn. Transferred to Glasgow, April 18. Aspirated: empyema developed and burst, discharging through wound and mouth about ½ to ¾ pint of pus; continued to cough up purulent material in great quantities until end of June. Since June has continued to cough purulent material to a lesser degree, with some short intervals of freedom; always made worse by exertion. Sent to Beckett's Park, April, 1919. The shoulder wound healed in May, 1919, after operation on humerus by Major Coupland, at Beckett's Park, but chest condition worse; therefore admitted Leeds General Infirmary for removal of foreign body in chest.

X-ray Report, Aug. 27, 1919.—An irregular-shaped fragment of metal in left chest, close to the posterior chest wall; it is fixed to the chest wall, or, if in lung, the lung is fixed. It is about 2¼ inches deep from X mark on posterior surface; moves slightly upwards on inspiration. There is much thickening of lung (or pleura) around the metal; I do not make out a fracture of ribs. Metal is on level with inner end of 2nd left interspace.

Examination of Chest, Aug. 29.—Semicircumference of chest ½ inch above nipple: right 18¼ inches, left 16½ inches; some of this may doubtless be attributed to muscular wasting incidental to ankylosis of shoulder; the expansion, however, of the upper part of right side of chest is much in excess of that of left; the note over upper and front part of chest is about equal. Immediately below the left clavicle there is a very small area of hyper-resonance. Vocal fremitus greater on right side than left (physiological); marked diminution of respiratory sounds over upper and front part of chest; from behind, general expansion on left side diminished; general impairment of percussion note and of vocal fremitus; entry of air much impaired all over back of chest. Cardiac dullness extends outwards to nipple line (of course lessened fullness of left lung is responsible for this).

Operation, Sept. 29.—Third left rib elevated; pleura opened; upper lobe of lung was very firmly adherent all over, and at base posteriorly adhesions were so dense that they had to be divided by scissors in order to free lung. The piece of shrapnel was surrounded by extensively firm adhesions at posterior upper aspect of lower lobe; adhesions were separated with great difficulty and foreign body removed. Pleura closed; 3rd rib was broken, but was replaced and held in position by a suture through costal cartilage.

Bacteriological Report.—The foreign body gave a copious growth of coliform bacilli.

After operation a considerable surgical emphysema followed, which extended over neck and face; subsided in four days. Sept. 3.—Chest was aspirated and 10 oz. of blood-stained serum withdrawn. Sept. 5.—Chest again aspirated; no fluid. Sept. 18.—Chest opened, and blood-stained fluid drained away gave a prolific growth of coliform bacilli. After this gradual slow improvement; posterior wound discharged till December.

Dec. 20, 1919.—Gaining weight and strength. Still short of breath, and capable of very little exertion. Steadily improves.

Case 44.—**Shrapnel ball in pericardium. Removal.**

R. P., age 33. Admitted Aug. 29, 1919; discharged Sept. 25.

Wounded Aug., 1918, by shrapnel ball, which passed through right upper arm, axilla, and chest, until it lay behind the sternum. Patient complained of a good deal of pain behind breast bone and in right chest, especially on exertion.

X-ray Report, Sept. 1.—A shrapnel ball lies about 2 inches deep from X mark in anterior chest wall over inner end of junction of 6th costal cartilage and sternum. The metal moves downwards very slightly on inspiration, and there is movement synchronous with cardiac movement. I think the metal is lying in contact with the anterior surface of heart, probably attached to pericardium; lungs and diaphragm appear quite normal.

Operation, Sept. 5.—Elevation of 5th rib on right side; approach slowly made to shrapnel ball lying over heart within fibrous pericardium; foreign body loosened and removed by gall-stone scoop; cavity touched with pure carbolic acid; rib replaced and wound closed.

Bacteriological Report.—One colony of staphylococci.

Subsequent history uneventful; patient went home quite well on twentieth day.

Dec. 21, 1919.—"Quite well again."

Case 45.—**Foreign body in upper lobe of right lung. Removal.**

W. K., age 23. Admitted Sept. 15, 1919; discharged Oct. 10.

Wounded Sept. 19, 1918. *X*-rayed at 5th Southern General Hospital; no operation on chest; shrapnel removed from right arm.

Oct., 1918, transferred to 2nd Northern General Hospital; further operations on arm; incision in chest over 1st, 2nd, and 3rd ribs: pus found superficially; therefore not divided. Discharged July, 1919, and started work. Immediately he began working he commenced coughing, and sputum was streaked with blood. On Sept. 4 had severe hæmoptysis and was taken to Beckett's Park. Breathlessness came on with severe exertion, but patient could walk without discomfort.

Examination of Chest, Sept. 18, 1919.—Upper part of chest (infraclavicular region) is, I think, slightly less prominent on right side. There is no definite difference in the percussion note, which

is perhaps slightly impaired at right apex behind. The vocal fremitus is better felt at right apex than left (normal); the breath-sounds are everywhere rather imperfectly heard (a 'silent' chest).

X-ray Report.—Foreign body localized in chest. There is a metal fragment 2¼ inches deep, immediately behind inner end of clavicle. *Slight upward* movement on inspiration; I think it is in the upper lobe (inner part), and that the lung is adherent to the chest wall; a little opacity showing over upper part of right lung.

Operation, Sept. 19.—Third right rib elevated, pleura opened; adhesions round upper part of right lobe exceedingly dense, elsewhere slight; all separated. Foreign body found in upper lobe, towards inner side; removed, and lung sutured.

Bacteriological Report.—One colony of coarse diplobacillus found.

Subsequent history quite uneventful; discharged well in five weeks.

Case 46.—**Foreign body in middle lobe of right lung. Removal.**

S. C., age 38. Admitted Sept. 29, 1919.

Wounded July, 1916, by shell. Hæmoptysis; sent home to David Lewis Hospital, Liverpool; operation performed; "no shrapnel extracted." Back to depôt Dec., 1916. Mar., 1917, went back to France; very breathless, and felt unfit for duty. In July, 1917, hurt his knee and was sent home; invalided out of service in 1918. Started work; had to give up; began again; finally gave up in April, 1919, on account of breathlessness, pain, 'shivers,' and weakness.

Examination of Chest.—Right side of chest not so full as left; note a little impaired at upper part of right lung behind, and breath-sounds a little harsher on right side front and back.

X-ray Report.—A metal fragment in right middle lobe, 4 inches deep from X mark on anterior surface; movement downwards on inspiration; diaphragm moves freely; patchy opacity in chest round fragment.

Operation, Oct. 10, 1919.—Fifth right rib elevated; pleura opened; very many dense adhesions; heart well over to right. Foreign body felt in upper part of middle lobe, embedded in a hard, yellow, almost calcareous mass; incision and suture of lung as usual.

Bacteriological Examination.—Very numerous bacteria; probably degenerate pneumococci. Culture gave a pure growth of pneumococcus.

Surgical emphysema followed operation.

Nov. 1.—Fluid present in chest; removed; pure culture of pneumococcus; incision and Carrel tubes; healed gradually, and closed by Dec. 1.

Dec. 21.—Good progress. Up and about; eating well, and "enjoying life."

Case 47.—**Foreign body adherent inside pleura at level of 6th rib. Removal by posterior incision.**

D. B. S., age 37. Admitted Oct. 27, 1919; discharged Nov. 11.

Wounded by shrapnel Aug., 1915, under right shoulder-blade. In 23rd General Hospital, Etaples; no operation; no *x* ray. Went back Dec., 1915. Felt pain from right shoulder-blade to lower end of spine, but was able to carry on as corporal R.E., not having any heavy work to do.

May, 1917.—Sent to England, Class W Reserve, to work on munitions. This (iron-stone mining) was heavy, and patient was unable to work more than three or four days at a time; obliged to give up.

Feb., 1919.—In bed nine weeks, and on getting up had difficulty in walking and stooping on account of pain in back. The pain is of a fierce burning character when patient exerts himself, but is better with long rest; is located across bottom of back, and up to right shoulder-blade; no difficulty in breathing.

Chest Examination, Oct. 30.—Practically negative. The two semicircumferences are identical; right upper part of chest preserves its normal excess of vocal fremitus; am not sure that breath-sounds are quite so good over upper part of right side; no spitting of blood at any time; is quite free from cough, and it appears to me that his symptoms are of too wide a distribution to be connected with the pressure of the foreign body ("pain along my back from the shoulder downwards").

X-ray Report.—Foreign body in chest, firmly attached to 6th rib behind; lung seems normal.

Operation, Nov. 7.—Posterior incision; portion of rib removed, and foreign body; pleura opened; few adhesions. Healed by first intention; discharged well on fifteenth day.

Case 48.—**Foreign body in lower lobe of left lung.**

T. M., age 24. Admitted Nov. 7, 1919.

Wounded April, 1917, by shrapnel; operated on at Glasgow, but shrapnel not removed. Left hospital Jan., 1918, still having pain in chest and wound, and difficulty in breathing. Discharged 1919, and started work, but had to give up on account of difficulty in breathing and pain; coughed up a large amount of phlegm, occasionally streaked with blood.

X-ray Report, Nov. 10, 1919.—A small metal fragment in the upper and outer part of left lower lobe; 3½ inches deep from X mark on posterior surface (marked also on anterior surface); very slight downward movement on inspiration; considerable opacity of lung surrounding the metal, and lung is adherent to chest wall.

Chest Examination, Nov. 18.—The percussion note is somewhat impaired at left part. The vocal fremitus is less on left side than on right, but the difference is, I think, within physiological limits. A greater lessening of breath-sounds over left lung generally than I should have expected from above-noted signs.

Operation, Nov. 28.—Fifth rib on left side elevated; pleura found ¾ inches thick; no pleuritic cavity remained; lung itself felt very solid. The foreign body was the size of a Barcelona nut, embedded in midst of dense hard lung about ¾ inch from surface, very close to pericardium.

Case 49.—**Machine-gun bullet in apex of right lung.**

M. T., age 28. A machine-gun bullet entered on April 6 behind the acromial end of the right clavicle, and is now shown by *x* rays to be in apex of right lung behind inner end of clavicle. At the time of being wounded had difficult short and painful breathing for a few hours, and hæmoptysis for about one week in small quantities; nothing done in the way of trying to extract the missile. There was no mention, so far as he knows, of a hæmothorax; no nerve or bone injury. Now he has no respiratory difficulty, but fourteen days ago, and occasionally since, he has had hæmoptysis, on one occasion severe, the others slight; physical signs of the right chest normal.

Operation, Nov. 23, 1919.—Right 3rd rib reflected; many adhesions of the lung to chest wall found; most of these thin and easily separated, but two or three so strong and thick as to require cutting with scissors. The bullet was firmly embedded in right upper lobe; it was removed, and the lung did not require stitching; wound stitched up as usual; the pleura did not come together well; rib stitched back in place; healed quickly. Convalescence easy and rapid; left hospital on eighteenth day. Foreign body sterile.

Dec. 10.—The lung on examination seems to have returned to the same condition as before operation. Expansion is perfect.

Jan. 16, 1920.—"As fit as ever."

I desire to express my grateful appreciation to my colleague, Dr. T. Wardrop Griffith, C.M.G., for much valuable help and wise counsel, and to thank Captain E. R. Flint for his skilful assistance in all the operations performed, Dr. Scargill for the *x*-ray photographs, and Miss E. M. Wright for the drawings.

ON THE HISTOLOGICAL RESEMBLANCES OF ORIENTAL SORE TO EPITHELIOMA.

By WILLIAM MACADAM, Leeds.

While in the East the writer had the opportunity of examining histologically a number of excised skin lesions of the type of Oriental sore, sometimes called Baghdad boil, Delhi sore, etc. Most of them showed the characters of a chronic ulcer, those of greater chronicity having some epithelial downgrowth at the margin, but in two instances the histological characters were such as to be practically indistinguishable from a squamous-celled carcinoma.

Accounts of the histopathology of these 'Leishmania' lesions have been given in various communications and in text-books of tropical medicine. The chief point emphasized is the resemblance to the histological appearances of a chronic granuloma. Wright,[1] in his original paper, says that the lesion consists essentially of a very extensive infiltration of the corium and papillæ by round cells, viz., various types of lymphoid cells, plasma cells, and numerous large endothelial cells, containing a single vesicular nucleus and a relatively large amount of cytoplasm. Balfour and Thomson[2] describe the presence of cell-nests associated with epithelial proliferation in two cases of the non-ulcerating or keloid type of Oriental sore. They consider that, although there are long branching epithelial down-growths into the underlying tissues, there is no actual invasive process, nor are there any isolated masses of prickle cells, the condition in these respects resembling a papilloma. Archibald[3] has described another case which presented ulcerated as well as nodular lesions, while histological examination showed a few cell-nests and isolated masses of cell infiltration. As will be seen, in the cases described below, there is a very extensive epithelial invasion of the underlying tissues, with the formation of numerous cell-nests, so as to present very marked histological resemblances to squamous-celled carcinoma.

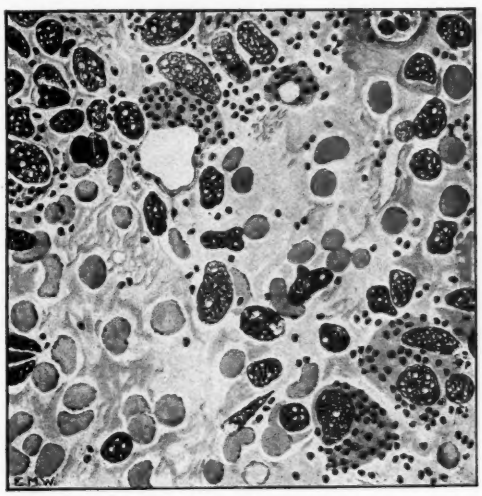

Fig. 400.—*Leishmania tropica.* Drawn from smear of granulation-like material of excised ulcer histologically resembling a squamous-celled carcinoma.

The first specimen was a sore of quite typical naked-eye appearance. It had appeared about three months before coming under the writer's observation, as a tiny papule on the forearm of a private, while the man was on service in Mesopotamia. When first seen, it was a shallow ulcer with slightly heaped-up edges about three-quarters of an inch in diameter, and covered by a thin yellowish scab, while the surrounding skin was quite healthy looking. There was no enlargement of the associated lymph-glands. Excision of the sore was carried out, not because there was any reason to suspect early malignancy, but simply because it was considered to be the most rapid method of cure, the sore, as is not infrequent, being a solitary one. The specimen was cut through its centre. One portion was examined by making smears from the pinkish granulation-like material in the cutis

vera, and on applying Leishman's stain, typical *Leishmania tropica* bodies were found to be present in large numbers. (*See Fig.* 400). The other half was submitted to histological examination, and a drawing of a section stained by hæmalum and eosin, taken from the edge of the ulcer, is shown in *Fig.* 401.

The base of the ulcer shows numerous down-growths of squamous epithelium associated with considerable round-celled infiltration. Its edge is somewhat abrupt. The surface epithelium is moderately keratinized. The downward infiltration by epithelial proliferation is seen to be extremely marked, while in parts cell-nests are a characteristic feature. Blood-vessels are well formed, but there is no evidence of endothelial proliferation within them. There is considerable round-celled infiltration, the cells being mostly lymphocytes and large endothelial cells. No giant cells are seen, although those of the 'foreign body' type were found in other sores examined.

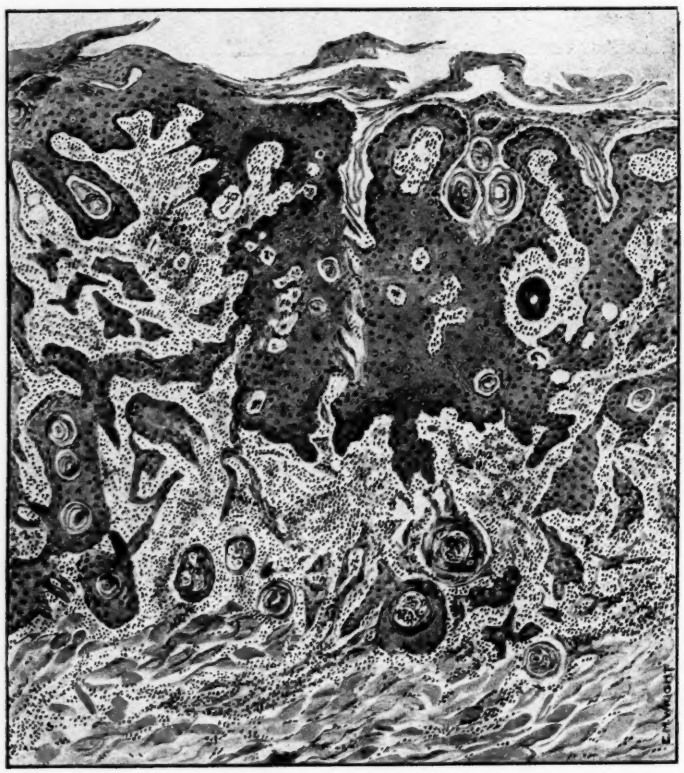

FIG. 401.– Drawing (× 62) of vertical section of edge of Oriental sore, showing marked epithelial down-growths and extensive cell-nest formation. There is considerable round-celled infiltration, chiefly lymphocytes, and large endothelial cells.

A snipping of an ulcer of the lip, from another case with multiple Oriental sores, presented a similar histological appearance, as well as showing the presence of 'Leishmania tropica' in smears. All the lesions, including the one which had the histological appearance of a squamous-celled carcinoma, healed up readily under treatment with intravenous injections of antimony tartrate. Sores examined from five other cases had the appearance of chronic granulomata, some showing giant-cell formation. It was not possible to examine a larger number, as excision was only carried out under special circumstances. The writer, however, while in India came in touch with two other cases of ulcerating skin lesions which had been reported, on histological examination, as squamous-celled carcinoma, and which had subsequently reacted readily to antimony treatment.

There is the possibility that a certain number of these ulcers in their chronicity may

take on the characters of a true carcinoma, although it is to be noted that in most instances, even when untreated, Leishmaniasis appears to be a self-limited infection. In the two cases described there is no evidence of clinical malignancy. They were both of relatively short duration; they had not the usual naked-eye characters of a chronic or callous ulcer; while in one instance the wound healed by first intention after excision, and the other cleared up speedily after intravenous injections of antimony tartrate. It may also be mentioned that lower animals have been infected with Oriental sores by inoculation, but there is no record of any carcinomatous lesions having resulted from such experiment. It is of interest, however, to remember that lesions of true carcinoma have been described by Ferguson[4] as following the papillomatous proliferation of the mucous membrane of the bladder produced by one of the entozoa, viz., *Bilharzia hæmatobium*.

Another difficulty of diagnosis is that, in a sore of some duration where early malignancy may be a probability, it may be impossible to detect the *Leishmania tropica*, for the parasites tend to disappear in lesions of some months' standing. In the present instances this difficulty was not encountered. Considerable care has to be taken in the selection of material for the preparation of smears. It is quite futile to examine the base of the ulcer, or the purulent secretion of the surface. In the recent sore, serum drawn off by a capillary pipette from the hyperæmic edge, or preferably from the tiny vesicles often present, and the smear stained by Leishman's or Giemsa's stain, may reveal the presence of the Leishman-Donovan bodies in large numbers. In the more chronic lesions it is often necessary to obtain the smear material from a deeper level of the ulcer, and a small Volkmann's spoon is often found useful in obtaining the softish granulation-like tissue, which usually shows the parasites in largest numbers in such cases. Sometimes, especially in the nodular or keloid type of Oriental sore, as in a case kindly shown to the writer by Dr. Row, of Bombay, although the Leishmania bodies cannot be detected in smears, it is possible to demonstrate the presence of the parasites by cultural methods.

Detection of the infecting agent by such means is of great importance, in view of the fact that the histological appearances of the lesion may sometimes bear such a striking resemblance to squamous-celled carcinoma. From the practical standpoint, these observations may be of some surgical interest, especially at the present time, when so many men have recently returned to civilian life after residence in countries where Leishmaniasis is endemic. Certainly, suspicion that the condition is not one of ordinary epithelioma ought always to be aroused when such epithelial down-growths and cell-nest formation, as above described, are found associated with a markedly granulomatous type of lesion.

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[1] Wright, *Jour. of Medical Research*, 1903, x, 472.
[2] Balfour and Thomson, *Fourth Report of Wellcome Tropical Research Laboratories, Khartoum*, 1911, Vol. A, 191.
[3] Archibald, *Ibid.*, 207.
[4] Ferguson, *Glasgow Med. Jour.*, 1913, lxxix, 14.

INTUSSUSCEPTION OCCURRING IN THE COURSE OF TYPHOID FEVER.

By A. L. MORETON, London.

> "There is no disease, in fact, which exhibits a more protean character, from predominance of certain symptoms, and from the presence of complications." (*Murchison.*)

The occurrence of acute intussusception in the course of fevers of the typhoid group would appear to be one of the rarer complications of a group of diseases well known for the number and variety of the complications that may be met with. The importance of recognizing the condition, or, at least, of realizing the necessity of an exploratory operation, is great. The object of this paper is to place on record a case that came under my own observation, and to review briefly the literature of the subject.

The rarity of the condition may be estimated from the few references that are made to it in the standard text-books on medicine and surgery. Murchison's classical treatise, *On the Continued Fevers of Great Britain*, 3rd ed., 1884, from which I have taken the quotation at the head of this paper, makes no mention of it; while the same is to be said of Allbutt's *System of Medicine*, 1905, and Nothnagel's *Encyclopædia of Practical Medicine* (Stengel's translation, 1904). T. Macrae (Osler and Macrae, *A System of Medicine*, 1907) refers to intussusception as one of the conditions, apart from specific bowel lesions, that may cause abdominal pain in typhoid fever. He says that "several instances of this have been reported, in one with hæmorrhage, the diagnosis of perforation being made."

Sir G. E. Armstrong[1] mentions the occasional occurrence of intussusception in typhoid fever, and quotes the paper by O. C. Smith, to which I refer later. W. W. Keen, in his classical volume, *Surgical Complications and Sequelæ of Typhoid Fever*, 1898, makes no mention of the matter; while A. E. Webb-Johnson[2] states that "volvulus, intussusceptions, and other conditions leading to intestinal obstruction, arise from time to time during the course of typhoid-group infections"; but apparently he did not meet with any cases of this complication as a result of his experience with the British armies in France during the recent war.

The following is the record of a case admitted on the medical side of St. Bartholomew's Hospital in 1918, under the care of Dr. J. H. Drysdale, whom I have to thank for giving me the opportunity of dealing with the case.

Case 1.—The patient was a girl, age 24, a clerk, whose illness began on April 3 with headache and anorexia. These symptoms were followed in the next week by those of obstinate constipation, pain in the right hypochondrium on coughing, and tenderness in the cæcal region. On April 13 she was admitted to hospital as a case of typhoid fever. At this time she was pale, with cyanosed lips. Her tongue, on each side of the middle line, was coated with thick fur. Rose spots were found on the thorax and abdomen. The lower pole of the spleen was felt 1½ inches below the costal margin in the nipple line. The temperature was 102·2°, the pulse-rate 116, and a leucocyte count 11,000. Dreyer's test to *B. typhosus* was positive 1–500. Under treatment, her abdominal pain and tenderness subsided; but constipation was still a marked feature of the case. The bowels were moved every second day with enemata.

From April 22 to 29 she vomited once a day. After the latter date the abdominal symptoms remained in abeyance until May 19, that is, until the forty-seventh day of the disease. Until then the temperature had been raised, although not typical, but rather of the remittent type. On that morning the temperature fell suddenly to 97·8°, and the patient had a severe attack of vomiting. The pulse-rate was not raised. The distention was not increased, and the area of liver dullness was normal. The abdomen moved well on respiration. On the afternoon of the next day the

pulse-rate rose from 120 to 140, and the temperature remained about the same. The pain became localized in the right iliac fossa, and of a colicky nature. Three small stools were passed, but contained no blood. The vomiting continued. A blood-count showed 13,400 white cells per cmm., indicating a slight leucocytosis as compared with the count on admission; but it could not be taken as good evidence of perforation, as there had never been typical leucopenia. At a consultation held this day it was decided, probably in error, that there was no definite indication for operation. The signs were not those of perforation; and a hæmorrhage was suspected. The following day, May 21, another small stool was passed; but again no blood was seen in at. The pulse-rate was 136. In the afternoon the pain had become very acute, and the patient rolled in agony. The abdomen was distended, but moved evenly and well on respiration. The right iliac fossa was exquisitely tender, and examination revealed an ill-defined resistant mass. The area of liver dullness was normal. An exploratory operation was decided on. Although the signs characteristic of perforation were absent, it seemed the most probable cause of her condition notwithstanding. Other possibilities were that the case was one in which a slow leaking had taken place, and the leak been shut off by adhesions; or that it was a case of localized peritonitis without macroscopic perforation.

OPERATION.—The abdomen was opened, under general anæsthesia, by means of an incision through the lower part of the right rectus sheath. On reaching the peritoneal cavity a fair quantity of clear straw-coloured fluid, slightly blood-stained, was noticed. No gas escaped. The ileum was congested and distended; the colon pale and empty. A mass was felt in the ileo-cæcal region. This was found to be an intussusception. It was of the enterocolic variety, or rather an enteric intussusception which had become enterocolic. Its apex was at a point of the ileum five inches from the ileocæcal valve. This had become invaginated into, and had extended four inches up the lumen of, the ascending colon. The ileocæcal valve was not invaginated, so that the intussusception was of the subdivision 'iliaca-ileo-colica' (H. L. Barnard, *Contributions to Abdominal Surgery*, 1910). The cæcum and appendix were not involved, but the cæcum was considerably distended with gas, as might be expected. The intussusception was reduced without difficulty. Its apex was congested, stiff with œdema, and showed many subperitoneal hæmorrhages. No localized lump could be felt at the apex, such as a swollen Peyer's patch, that might have been the cause of the intussusception. No perforation was found. The wound in the abdominal wall was sutured in three layers without drainage.

The following day the patient was greatly relieved. She had vomited once shortly after the operation, but not again. She took readily all that was given her. The bowels acted twice with enemata. On the tenth day after operation the stitches were taken out, and the wound was found to be healed by first intention.

Her further history was devoid of surgical interest, but not uneventful. She had epistaxis. Hæmorrhagic spots appeared on the chest and back. Finally, she developed typical faucial diphtheria, the infection being apparently conveyed by a relative who visited her in the ward. She was discharged cured on August 30, 1918, after a stay in hospital of nearly twenty weeks.

I have found ten other cases of this condition mentioned in the literature. A short abstract of these follows:—

Case 2.—H. Pernet[3] describes a most remarkable case that was under his care. His patient was a male infant, age 2, 'who presented a train of symptoms which, added to the fact that an older sister had the same disease, confirmed the diagnosis of typhoid fever.' On the tenth day of the disease the patient was 'seized with intractable vomiting, accompanied by high fever, extreme thirst, abdominal distention, and all the signs of violent peritonitis.' Perforation was diagnosed. He passed no fæcal material, but occasionally some blood-stained serum and blackish clotted blood. The bleeding so enfeebled him that a speedy end was expected. On the following day, in a most violent paroxysm of colic, he passed per anum a segment of intestine 10 cm. long, soft, swollen, and black in colour. With this was passed a considerable quantity of blood. The patient was bloodless and his pulse thready. The vomiting stopped at once, and he fell into a deep sleep. The next day he had a normal evacuation of the bowels, and twelve days later 'he was completely recovered.'

Pernet showed the specimen at a meeting of the Medical Society of Elbœuf. It consisted of the extruded portion of intestine, which had become strangulated and detached. It was of the colour of wine-lees. At the end where separation had taken place, the diameter of the specimen was less than at the other extremity (i.e., the apex of the intussusception), and it ended almost in a point. The apex was 'widened, flat, and irregular, like a cauliflower.' The lumen admitted a probe with difficulty.

This observer justly remarks upon: (1) The occurrence of typhoid fever in so young a patient; (2) A complication, or at least a coincidence of the greatest rarity; and (3) The possibility of recovery after an 'internal strangulation, with expulsion of the gangrenous part, by the end-to-end union of the two ends of intestine.'

Case 3.—J. Vincent[4] gives the case of a soldier of the Foreign Legion, admitted to a military hospital on Oct. 10, 1894, on the eighth day of an attack of typhoid. The case was one of moderate severity. After a week's treatment the temperature began to fall. Diarrhœa stopped

on Oct. 27, and the patient was definitely convalescent at the beginning of November. He was about to be discharged, convalescent, when on Nov. 11, the fortieth day of his disease, he had a sudden attack of abdominal pain, and vomited several times. He lay on his back, doubled up with pain. Pulse 120. T. 36·2° C. He complained of a dull diffuse pain, with colicky exacerbations. There was no effusion, no deep-seated thickening in either iliac fossa. Only in the middle line below the navel did the patient complain of definite pain on pressure. In this situation was an area, about 15 by 20 cm., dull on percussion. There was no abdominal distention. The bowels had acted twice since the previous evening, and no blood or pus was noticed in the stools.

A definite diagnosis was not made, and expectant treatment was adopted. An enema resulted in a loose stool, but there was no relief to the symptoms. Later in the day his general condition became worse. The pulse-rate rose. There was incessant vomiting, bilious in character, not fæcal. The abdomen became more distended. The area of the subumbilical dullness remained as before. The patient died the same night.

Post mortem there was no fluid in the peritoneal cavity, and no peritonitis. The stomach, duodenum, and proximal part of the jejunum were considerably dilated. Thirty centimetres from the duodenojejunal flexure there was an intussusception, of the descending variety. The lumen of the gut was completely obliterated; '5 to 6 cm. of intestine were invaginated.' The neck was stretched, white and bloodless. The intussusception was withdrawn with difficulty. The mucous membrane was not ulcerated. 'A little further down' the course of the jejunum was found the beginning of a second intussusception. A piece of small intestine, at its antimesenteric border, was invaginated for 2 or 3 cm., but the obstruction was not complete. No tumour, polypus, or cicatricial contraction was found in the intestinal tract. The typhoid lesions had been entirely repaired without leaving a trace.

Case 4.—A. E. Ash[5] records a case occurring in South Africa during the second Boer War. His patient was a sergeant, age 25, under his care with typhoid fever. A relapse of low type set in on the fortieth day. On the forty-ninth day the patient was suddenly seized with abdominal pain, and vomited. He was thought to have a perforation. Under an anæsthetic, six hours after the onset of symptoms, a mass was felt in the right iliac fossa. Laparotomy was performed, and an 'ileocolic' intussusception, 6 inches long, was reduced. Reduction was effected 'with some difficulty, the condition of enteric ulceration lending additional danger.' The patient made a good recovery.

Cases 5, 6.—A. E. Ash also records the experience of the officer commanding his hospital, Lieut.-Colonel Jennings, who told him he had twice seen cases of typhoid fever in India in which, post mortem, ileocolic intussusceptions had been found. In each case death had followed symptoms like those of perforation.

Case 7.—R. H. Harte and A. P. C. Ashurst[6] state that they saw a case of intussusception occurring during an attack of ambulatory typhoid; but no details are given and the result is not stated.

Case 8.—B. L. Bryant and J. S. Bragg[7] describe a case occurring in a man, age 23. On the thirty-ninth day of his illness he had a sudden attack of pain in the right iliac fossa, followed by a slight action of the bowels. There was great tenderness one inch above McBurney's point. The case was thought to be one of perforation, and an operation was performed by W. C. Mason. Three intussusceptions were found. In all three the ileum alone was concerned. The three lesions were close together in the terminal part of the small intestine. One was three inches, one five inches, and one eight inches long; so that, in all, a considerable length of intestine must have been involved. Several 'infiltrated patches' and enlarged Peyer's patches were noticed. The intussusceptions were reduced, and the abdomen closed. The patient died five hours after operation.

Cases 9, 10.—G. G. Ross and H. F. Page[8] describe two cases. In the first, operated upon by Ross, a boy, age 17, with typhoid fever, was awakened on the twenty-sixth day with violent abdominal pain. He was thought to have perforated. Operation disclosed an intussusception three inches from the duodenojejunal flexure. Reduction was effected, and the patient made a good recovery.

Their second case was that of a girl, age 19. On the forty-first day her abdominal pain became much more severe, and 'peristalsis was increased.' A white blood-count showed 11,000 leucocytes. Intussusception was diagnosed, and laparotomy performed by Deaver. A large ulcer was found near the ileocæcal junction, and an intussusception at this point; 25 cm. of ileum were invaginated into the cæcum. The intussusception was reduced, and the patient recovered.

Case 11.—O. C. Smith[9] records a case in a girl, age 20, occurring in the first week of the disease. There was a temperature of 105°, considerable abdominal distention, a point of maximum tenderness 1 inch mesial to McBurney's point, and rigidity of the right rectus. Per rectum, a tender, movable mass was felt in the right pelvic fossa. A provisional diagnosis was made of enteric fever with sudden onset, and, probably, appendicitis.

At operation the ileum was found to be invaginated into the cæcum for a distance of 4 to 5 cm. The intussusception was reduced, two large thrombi were removed from the mesentery, and the appendix also was removed. The ileum was sutured to the peritoneal wound close to the ileo-cæcal junction, and the parietal wound drained. The patient recovered.

The diagnosis of typhoid fever was confirmed later by the characteristic diarrhœa, roseola, and a positive Widal's reaction. The wound was 'practically healed' at the end of the fourth week, and convalescence established at the seventh week.

The number of cases abstracted above, together with the one described in the first part of this paper, eleven in all, is too small for dogmatic statements to be made with confidence. However, an analysis brings out the following points :—

Age Incidence.—Excluding the case occurring in an infant of 2 years, the average age of the patients was 21. This is what would be expected when the age-incidence of typhoid fever is remembered.

Sex.—Five of the patients were of the male sex, three were women, and in three cases the sex was not stated.

Period of the Disease at which Intussusception Occurs.—This was noted in 8 cases in this series, and it varied from the first week to the seventh week. One case occurred in the first week, 1 in the second week, 1 in the fourth week, 2 in the sixth week, and 3 in the seventh week. It is evidently towards the end of the disease that this complication is more likely to occur.

Variety of Intussusception.—The intussusception was enterocolic in 6 cases, enteric in 3 cases. In 2 cases the variety was not recorded. In 2 of the enteric cases there was more than one intussusception.

The Symptoms and Signs are those of a sudden abdominal catastrophe, of the nature of intestinal obstruction. There is a very severe and sudden attack of abdominal pain, or a sudden and violent increase of pre-existing pain. This is accompanied by free vomiting, and constipation. It is to be remembered, however, that if the obstruction be high up in the small intestine the constipation may not be absolute at first. The pain is frequently localized, and often in the right iliac fossa.

A swelling was felt in only 3 cases. In 2 of these it was felt in the right iliac fossa, and in the other in the right posterior quadrant of the pelvis on rectal examination. In one of the two cases in which the lump was felt through the abdominal wall, this sign was not made out until after the patient had been anæsthetized, while in the other (my own) it was not apparent until, probably, at least twenty-four hours after the onset of the process of intussusception. In only one of the cases in this series was a blood-stained discharge from the anus noticed.

The Diagnosis may be difficult, especially if the possibility of this complication is not kept in mind. Most of these cases were diagnosed as perforation. Except from the point of view of prognosis, this is not a serious error, as both conditions require immediate laparotomy. In attempting to distinguish between intussusception and perforation, one would be inclined to consider that in intussusception the sudden catastrophe is not quite so great, the pain is colicky, the abdomen is soft, abdominal movement is not restricted, a swelling may be felt on abdominal or rectal examination, there is no diminution of the area of liver dullness, and there is no increase in the leucocyte count. Further, the operative results are so good that an exploratory operation is always justifiable in doubtful cases.

Prognosis and Results of Treatment.—The prognosis is good in cases submitted to laparotomy. Of the 11 cases, 6 recovered, 4 died, and in 1 the result is not mentioned. An operation was done in 6 cases. Of these, 5 recovered and 1 died. Laparotomies are well borne by typhoid patients, apart from the usual conditions which cause them to be performed. Of the 5 cases in which operation was not performed, all died except the wonderful case in which recovery followed the passage per anum of the gangrenous intussusceptum.

Finally, one may inquire into the etiology of intussusception occurring in typhoid fever, and endeavour to see how far such an inquiry will bear on the question of the

etiology of acute intussusception in general. Its causation may possibly be explained by either of the following two processes.

1. "A lack of muscular tone due to inflammatory infiltration of the bowel wall in localized areas, permitting a greater degree of distention in different portions of bowel." (Ross, *loc. cit. infra*). This might cause obstruction to the normal peristaltic waves, leading to one segment of the bowel being invaginated into the segment immediately below it.

2. An enlarged Peyer's patch may project far enough into the lumen of the bowel for it to be gripped by the succeeding section of the intestine, and so start an intussusception in the same way that a polypus or other localized tumour may. In this connection it may be noted that the variety of intussusception in the case described in the first part of this paper (iliaca-ileo-colica) was thought by Barnard (*loc. cit. supra*, p. 228) to be usually due to a swollen Peyer's patch.

SUMMARY.

1. Acute intussusception is one of the rarer abdominal complications of typhoid fever.

2. It may occur at any time during the progress of the disease, but it is usually late in its course, or during a relapse.

3. It may be caused by irregular peristalsis due to inflammatory changes in the wall of the gut, or an enlarged Peyer's patch may start the process of intussusception.

4. The intussusception is more commonly of the enterocolic type. If of the enteric type, there may be more than one lesion.

5. The differential diagnosis from perforation may be difficult.

6. The prognosis is good if the patient be submitted to operation, and the results of operative treatment are better than those of perforation.

7. In reducing the intussusception at operation, it should be borne in mind that diseased bowel is being dealt with, and that the utmost gentleness should be used in all manipulations.

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DIFFICULTIES IN THE DIAGNOSIS OF NERVE FUNCTION.

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In the following article an attempt is made to draw attention to various small points which, when overlooked in the examination of a case of peripheral nerve injury, lead to errors of diagnosis in both directions, either by making the observer miss altogether, or minimize, the degree of injury to a particular nerve; or by making him conclude that recovery has taken place as the result of an operation, when the progress was really due to some other cause.

No apology is made for including observations which have been previously noted by other workers, for although nearly all the points can be found recorded somewhere, yet, in the author's experience, they have not obtained general recognition. Indeed, even when one is alert to the numerous possibilities of error, one may still be misled by an abnormality of nerve distribution which could only be diagnosed after an exploratory operation, and this is well illustrated by some case-records at the end. The practical importance of remembering the possibility of abnormal nerve distribution is that it often justifies early exploration in cases which are not improving, even though the lesion appears to be an incomplete one, because the symptoms may be due to actual division of one nerve, so that spontaneous recovery would never occur.

All the points noted below have been found of practical value in actual examination of the numerous cases of peripheral nerve injury which were treated in the Edinburgh War Hospital (Special Military Surgical Section).

The subject will be considered under the following headings: (1) *The patient's mentality*; (2) *Sensory difficulties*; (3) *Motor difficulties*; (4) *Abnormal nerve distribution*; (5) *The interpretation of electrical tests.*

The difficulties of estimating whether a particular nerve is functioning or not are not bounded by a knowledge of the anatomy and distribution of that nerve, as the inexperienced are apt to think. In some cases the difficulties are so great that only a series of examinations will settle the question. Indeed, as might reasonably be expected, in the early stage of nerve regeneration there is no hard boundary line between the condition of complete paralysis and that of commencing function; so that one week an observer, who has followed a case closely since operation, may feel certain that recovery has begun, though strangers see no evidence of it; and in two weeks' time there may be enough evidence to convince the most sceptical. In one case, where evidence of commencing recovery became definite six weeks after operation, the patient himself reported a sense of power in some of the muscles on the tenth day, though at this time no objective change could be found.

1. **Patient's Mentality.**—Naturally the difficulties of the observer are much increased if the patient, owing to mental inertia, or some other reason, refuses to take an intelligent interest in his own case, as all the evidence of nerve function is obtained through the medium of the patient's answers and actions. Some of the patients who are interested in themselves will in their anxiety (consciously or unconsciously) simulate recovery. If, however, the small precautions mentioned below are used, this source of error will be easily eliminated in respect of sensation.

2. **Sensory Difficulties.**—There are fewer traps in the sensory examination than in the motor. It must be remembered that when a limb is cold, sensation is much less acute. Thus, in cases of recovering epicritic sensation, where there are still punctate areas

of anæsthesia, if the patient's hand is cold, he may be unable to feel light touch at all or will localize it wrongly, whereas he may have responded accurately on a warm day; and this accounts for the variations from day to day in the sensory charts of a recovering nerve case. For this reason the man should always soak his hand in warm water for about twenty minutes before the examination. The heat also increases the excitability of weak muscles to electrical and voluntary stimuli, though if too prolonged it weakens their contraction. The patient's eyes must be kept closed while sensation is being tested, as he is apt to confuse the visual stimulus with that of touch, especially if he is anxious for improvement.

Sensory Errors.—When testing pin-prick the pressure of the pin should always be accompanied by that of the pad of the observer's finger; otherwise the patient will find it hard to distinguish between the pressure of the pin and its painful stimulus, with much consequent waste of time. The pressure sensation evoked by the pin is part of the deep pressure sense, and dependent on different fibres from those responsible for the epicritic pain sense. In our experience the deep pressure sense returns sooner, and is lost less often, than the epicritic.

In testing Tinel's sign, care must be taken not to be misled by tingling from an adjacent nerve, as in so many regions two or more have an identical course, e.g., the ulnar and internal cutaneous in the upper three-fourths of the arm. By asking the patient to mark out the peripheral distribution of the tingling, this error is avoided.

Muscle tenderness is sometimes hard to tell from nerve tenderness where the nerve runs through the muscles it supplies, as the ulnar does in the palm of the hand.

3. **Difficulties in Motor Diagnosis.**—The motor function of a nerve is the most difficult to test when it is impaired, because the movement characteristic of most muscles can be imitated by the combined action of neighbouring muscles; or if the muscle is too weak to move the joints, and the observer feels its belly for evidence of contraction, he may be misled by the tightening of the fascia over the paralyzed muscle, due to the pull of other muscles connected with that. This last difficulty arises particularly in reference to the pronator radii teres and flexors of the wrist, which all arise from the walls of the same compartment of the deep fascia of the forearm. Similarly the fascia is drawn tight over the extensor communis by contraction of the carpal extensors, and this closely imitates a contraction of an atrophied extensor communis itself.

When a muscle is weak or paralyzed, the brain stimulus, like the electrical one, is apt to overflow to all the neighbouring muscles, to the whole limb, or even to the whole body, and these widespread disturbances mask any small contraction of a weakened muscle. A sensible patient can be taught to eliminate these accessory actions, but in a man of weak intellect or will-power they form a great cause of difficulty in the examination and re-education of recovering muscles.

The following are the more common instances of simulated action which are liable to cause error.

Substitution in the Upper Limb.—

a. Abduction of the arm at the shoulder-joint, normally carried out by the deltoid, can be executed by a hypertrophied supraspinatus.

b. Flexion of the elbow, in the absence of the biceps, can be partially carried out by the supinator longus and pronator radii teres, and if the triceps contracts alternately with these, the biceps may be lifted forward in simulation of a weak contraction.

c. Extension of the elbow, in cases of paralysis of the triceps, may occur as a rebound from vigorous flexion, especially if gravity is allowed to act; therefore the triceps should always be tested with the arm abducted and the elbow working in a horizontal plane. When one or two heads of the triceps are paralyzed while the third is acting, it is often difficult to be sure which is affected, as the deep fascia tightens over the whole muscle.

d. When both pronators are paralyzed, pronation can be obtained for about half the normal extent by means of the supinator longus, and, if the flexor carpi radialis happens to have escaped, even better by that.

In cases of complete division of the median just below the supply of the pronator

radii teres, when therefore the pronator quadratus must be paralyzed, we have observed that pronation lacks the last few degrees, and also lacks force. The converse lesion is rare, and would be difficult to verify.

e. When all the three carpal flexors are paralyzed, together with the finger flexors, which have a subsidiary action on the wrist, that joint can still be palmar-flexed by the extensor ossis metacarpi pollicis.

A weak contraction of the flexor carpi ulnaris is difficult to confirm, as its tendon is always lifted forward, during flexion, by the flexor carpi radialis, and its belly difficult to isolate.

With regard to the palmaris longus, the middle-finger tendon of the sublimis is easily mistaken for this muscle ; this is prevented by holding the patient's fingers straight and the wrist in only slight flexion ; the sublimis tendon stands forward most in the last stage of strong closure of the fingers.

f. Flexion of the interphalangeal joints of the thumb and fingers is caused, in the absence of active contraction of the flexors, by the increased tension on their tendons which results during full dorsiflexion of the wrist and knuckles. This is much more marked if there is a considerable degree of contracture of the flexors. It is to be noted that when the first weak voluntary movements return in these muscles, they are only able to move the finger-joints in this hyperextended position, as they are incapable of dealing with any slack in their tendons. This corresponds to the well-known persistence of wrist-drop after recovery of the musculo-spiral nerve in some cases, where no cock-up splint has been worn during the paralytic stage to prevent over-stretching of the toneless extensors. The same phenomenon can be noted in the toes.

g. Extension of the wrist can be induced by a similar process through full flexion of the fingers, especially if the wrist extensors are at all shortened by splint treatment.

h. The return of power in the extensor communis is particularly hard to diagnose, as the synergic contraction of the unimpaired flexors of the wrist causes a falling of the wrist, while in that position the interossei alone would be sufficient to extend the fingers. It must not be forgotten that the interphalangeal joints normally depend for extension on the intrinsic muscles of the hand, although, if all the finger flexors are paralyzed by a combined median and ulnar lesion, the unopposed extensor communis is then able to extend all the joints ; as progressive recovery of the flexors occurs, the action of the communis on the interphalangeal joints diminishes proportionately, until finally it is restricted to the knuckles alone. Then, if no return of power appears in the intrinsic muscles, the long flexors roll the finger up on itself, in spite of all the efforts of the extensor communis, which only causes clawing, and the digit is useless for picking up objects (as shown in the diagram, *Fig.* 402, *b* showing the normal hand).

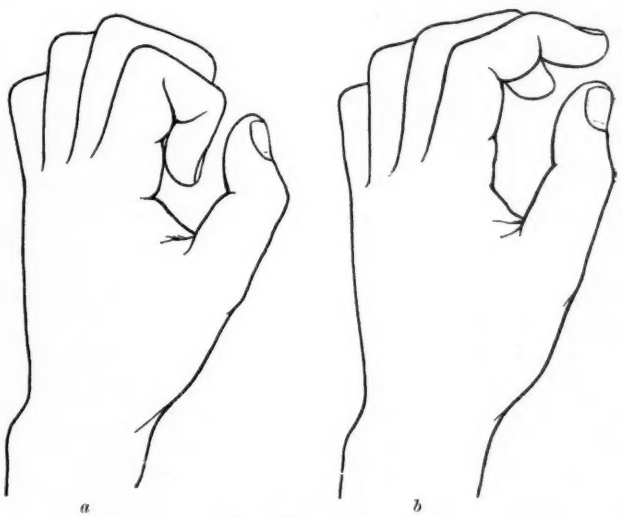

FIG. 402, *a*, *b*.

i. Extension of the terminal joint of the thumb is caused by the thenar muscles, though not with the same power as by the extensor longus pollicis.

j. As has been pointed out above, the extensor action of the interossei and lumbricals is not easily substituted, except by the one group for the other. As far as our cases

showed, the average extension due to a lumbrical was about equal to that obtained by the interossei which act on the same digit, and conversely; though in certain cases of ulnar paralysis the two fingers with a median supply to their lumbricals showed very weak extension, while other cases of median paralysis showed a similar weakness of those digits although all the interossei were acting.

The abductor action of the interossei is readily imitated by the extensor communis, except, of course, that the patient is unable to separate the fingers while keeping the knuckles flexed. The adductor action of the small muscles we have never seen imitated, except perhaps feebly by the extensor indicis; but no patient with true ulnar paralysis could ever show any gripping action by adjacent digits. Tinel reports that all except adduction of the little finger can be done by substitution. Of course, cases must be discriminated where the median nerve supplies more than its usual muscles, and vice versa.

k. Paralysis of the thenar muscles which are supplied by the median nerve (opponens, abductor brevis, and superficial head of flexor brevis) is often difficult to diagnose, although it may be suspected when there is flattening in the region of these muscles. The deep head of the flexor brevis (ulnar supply) is often well developed and can oppose the thumb to the little finger with great vigour, while the extensor ossis metacarpi (abductor longus) abducts it well. Even the combined action of these two, however, fails to give the rotation of the whole thumb which is associated with contraction of the opponens, and which can be appreciated by watching the direction that the nail faces. When the opponens and extensor ossis act together, they exactly imitate the action of the abductor brevis.

Substitution in the Lower Limb.—

a. Flexion and extension of the knee, in the absence of active movements, is apt to be produced by a rebound after the contraction of the opponents of the paralyzed group, especially if aided by gravity, and therefore these movements should be tested in the neutral position, and preferably in the form of resistance to the observer's hand, rather than as an actual movement; in cases of great weakness, the patient should be asked to support the limb against gravity by the suspected muscles. In this way tone may be detected in the muscles, even if no palpable contraction is obtained.

When the quadriceps is not acting, the tensor fasciæ femoris is found to have a weak extensor effect on the knee. Similarly the hamstrings are feebly imitated by the gracilis, and of course also by the gastrocnemii, but they are usually involved by the lesion which affects the hamstrings.

b. Plantar flexion of the foot, in internal popliteal paralysis, can be slightly obtained by the action of the peroneus longus.

c. Eversion of the foot, when the peronei are paralyzed, can be fairly well carried out by the extensor longus digitorum, which also has a strong dorsiflexing action on the ankle when the tibialis anticus is unable to act.

d. Inversion of the foot, it must be remembered, is caused by either the tibialis anticus or tibialis posticus, so that if only one of the popliteal nerves is injured, it is not lost; if both are affected, the other foot muscles are not likely to escape, and indeed none other has this action. Inversion of the heel is dependent on the tibialis posticus, the anticus affecting the part in front of the os calcis chiefly.

e. Flexion of the toes, like that of the fingers, can be imitated by the claw effect of the long extensors, when the intrinsic muscles are out of action.

It is necessary to add that patients rarely complain spontaneously of paralysis even of all the flexors of the toes and of the intrinsic muscles of the foot, as they would do with a corresponding lesion of the upper limb, and they may not notice the anæsthesia of the sole and toes; this explains the low percentage of operations which have been done on the posterior tibial nerve, as small degrees of sensory and motor impairment, which would be considered indications for operation on the nerves of the forearm, are not so regarded in the leg, and often are not noted at all.

The late stages of a posterior tibial paralysis may cause considerable discomfort to the patient, owing to the development of clawing comparable to that which follows ulnar and median paralysis, and also occurrence of trophic sores, resulting from friction of a boot

or from warming the foot in front of the fire. In this hospital we have not had the opportunity of examining sufficient calf wounds some years after infliction to determine the proportion which develop such changes.

4. **Abnormal Distribution of Nerves.**—These cases are impossible to diagnose with certainty before operation, and they are liable to be reported as rapid recoveries, unless they are early and carefully examined after operation.

In the Edinburgh War Hospital several cases have been seen where the median nerve supplied all the intrinsic muscles of the hand, though not the whole ulnar skin area. One case was seen where some of the median muscles were supplied by the ulnar, though again not its skin distribution.

The anatomists, especially Quain, and Poirier and Sharpey, quote numerous observations of an anastomosis between the median and ulnar nerves in the arm or forearm, as well as that of the cutaneous branch in the hand. On a few operation cases here, a communicating twig has been observed, though usually such would have been injured by the gunshot wound. It was not noticed in the cases which showed its presence clinically, having probably lain well out of the field of operation.

In none of the following cases were the sensory and trophic functions of the injured nerve taken over by its fellow, but they only showed improvement after nerve suture, and at a period when regeneration might well have occurred.

Case 1.—**Median supplying ulnar muscles.**

Pte. S., 1st R.S.F. Gunshot wound of left elbow, Nov. 1, 1916. Partial ulnar paralysis.

BEFORE OPERATION, at Bangour, May 2, 1917.—Found to have scar adherent to back of humerus, tender, with referred tingling down little finger. *Paralysis* of hypothenar muscles and 3rd and 4th dorsal interossei, not of other ulnar muscles. *Ulnar anæsthesia* (not on ring finger at all) to wool, prick, pressure; not joint sense. Hyperalgesia of the paralyzed muscles. *Trophic* changes slight.

OPERATION, May 8, by Col. Stiles.—Stiff elbow manipulated; sinus into internal condyle cleaned out. Ulnar nerve found embedded in scar in its course round internal condyle, and to consist of scar tissue for an inch and a half except for a narrow bundle of fibres along its inner aspect. An inch and a quarter resected; nerve transposed by dividing flexor origins; sutured with elbow at right angle.

Healed in three weeks, a little serum having drained at one point. *Motor.*—Profundus acts, also adductor pollicis, three outer lumbricals, abductor indicis.

AFTER OPERATION.—May 19.—*Anæsthesia* unchanged. *Trophic.*—Hand looks and acts almost normally, the only disability being in little finger. Good grip; no clawing. June 29.—*Faradism* to ulnar in forearm gave response in: flexor profundus, 3 and 4; adductor pollicis; outer interossei and flexor carpi ulnaris; the abductor minimi digiti and inner interossei responded to direct faradic stimulation. No response of median muscles during this stimulation, so that the response in ulnar must have been caused by a large anastomosis from median in forearm, not a direct median supply in hand. Sept. 8.—Trophic sore developed on little finger from burn; ulnar tender to wrist. Sept. 16.—Fell on elbow, this lit up the infection; healed October. November.—Contracture developing in little finger, which is cyanosed and shiny. May, 1919.—Recovery of all ulnar muscles (except 4th lumbrical), joint and pressure sense (not prick and wool); disappearance of trophic changes formerly noted.

The noticeable features of this case are the retention of power in the radial half of the ulnar intrinsic muscles after resection and suture of the ulnar nerve at the elbow, which can only be explained by the existence of a large communication from the median in the forearm; and the fact that the anæsthesia was complete after the operation, and only became reduced when there had been time for nerve regeneration; the same applying to the trophic changes, which, however, were less widely distributed than in the average ulnar case.

Case 2.—**A similar case.**

Pte. McC., H.L.I. Gunshot wound of right elbow, Aug. 8, 1916.

BEFORE OPERATION.—Nodule on ulnar in wound; 'pins-and-needles' in ring and little finger.

FIRST OPERATION, April 17, 1917.—Two and a half inches of ulnar nerve resected at elbow for neuromata in scar tissue. Ulnar transposed beneath flexor origins and sutured with elbow at right angle.

SECOND OPERATION, Aug. 21.—Neuroma one inch by a third of an inch found on ulnar in arm, resected; sutured with elbow flexed.

AFTER OPERATIONS.—Oct. 5.—All ulnar muscles act, though small ones weak (note by Capt. Bramwell). Typical ulnar anæsthesia; still some pain in ulnar distribution. Grip good. May, 1919.—Return of all sensation (except to wool of dorsal ulnar branch). All muscles act. Grip, R. 19, L. 24. Writes with left hand.

Case 3.—**Similar case, but less extensive median supply.**

Pte. McC., Munster Fus. Gunshot wound of left forearm, Sept. 24, 1916.

BEFORE OPERATION, Jan. 28, 1917.—Paralysis of all ulnar small muscles except adductor pollicis and abductor indicis. Ulnar anæsthesia to prick and wool. No trophic changes.

OPERATION, Jan. 30.—Transposition and suture of left ulnar, which was found hard for half an inch just above branch to flexor carpi ulnaris, which was spared. Elbow flexed to 60°.

AFTER OPERATION.—Feb. 6.—Abductor indicis and adductor pollicis acting; not profundus or flexor carpi ulnaris. April 13.—Recovery of flexor carpi ulnaris. June 15.—Recovery of profundus 3 and 4 (feeble). June 9.—Trophic sore on little finger; contracture of it has developed. Oct. 10.—Still complete ulnar anæsthesia to wool, prick, pressure, joint and muscle pain. Abductor minimi digiti acting feebly.

Case 4.—**This case illustrates the converse, i.e., supply by the ulnar of median muscles apparently a rarer phenomenon.**

Pte. C., W. Riding.—Gunshot wound of left arm, May 20, 1918. Ulnar and median injury.

BEFORE OPERATION, July 15.—*Motor.*—All ulnar muscles act, and thenar ones; no other median ones. Median anæsthesia to wool, prick, and pressure. Median and ulnar acutely tender in wound. *Trophic.*—Median area scaly and cold; no other trophic changes.

OPERATION, Oct. 24, by Colonel Stiles.—Suture of median and freeing ulnar in arm. Plaque of scar 4 in. by 2 in. found on neurovascular bundle in arm; good faradic response in ulnar, easily freed; median ended in scar; 2-in. gap; no faradic response.

AFTER OPERATION.—Nov. 20.—Abductor pollicis and flexor brevis pollicis still act, and all ulnar muscles. Jan. 10, 1919.—Profundus 1 now acts feebly. May 5.—Recovery of all median muscles; flexion of index weak. Ulnar good. Recovery of pressure and joint sense in median.

5. Electrical Tests.—Into the elaborate subject of the difficulties in obtaining satisfactory electrical reactions, their significance, and their order of return, it is not proposed to enter here, because it has been impossible in this hospital, owing to repeated administrative changes, to obtain a continuous series of uniform records.

It may be a useful reminder to mention that the electrical responses are difficult to obtain if the limb is cold, and it should therefore always be given a soak in warm water, before they are attempted.

In nearly all the cases which we have observed continuously, weak voluntary contractions have appeared before a response to faradism; but in several pensioners who had received no treatment for months after a nerve suture, and then reported here, a faradic response was obtained in muscles which appeared to have made no voluntary recovery; however, immediately or shortly after the application of electricity, voluntary contractions were obtained, showing that the patient really lacked re-education. This provides an argument for giving cases prolonged after-treatment under the surgeon who has seen the lesion at operation.

The testing of the exposed nerve at operation by a very weak faradic current gives valuable information as to the condition of the motor fibres, especially where a positive response is obtained; but this does not eliminate the need for judgement by the surgeon in dealing with partial lesions, where it may prove best to sacrifice a few intact motor fibres in order to suture satisfactorily sensory fibres which have been damaged and which are of supreme importance, such as those of the median. On the other hand, a nerve which fails to respond to faradism at operation may yet have the power of recovery when it is relieved from severe compression, as shown in the case recorded below

Such then are the difficulties which beset us in determining whether: (*a*) A given lesion is partial and recoverable, or complete; (*b*) A case has improved since operation, and whether the improvement is due to the operation.

Case 5.—**Lesion at first thought incomplete, because opposition of thumb was powerful. Suture of median in forearm.**

Pte. B., age 19. Admitted to Bangour, Nov. 10, 1918. Wounded early September, 1918. Immediate tingling in hand, which cramped into flexion. Healed end of October, 1918.

On Admission.—Punctured entry scars on inner side of left wrist (tender) and elbow. Joints free. *Motor.*—Paralysis of abductor and opponens pollicis, but powerful flexor brevis which imitated opponens. *Sensory.*—Median anæsthesia (one and a half fingers) to wool and prick. Joint and pressure sense lost in terminal joint and phalanx of index. Median small muscles analgesic. Median tender in lower third of forearm. *Trophic.*—Unhealed sore from burn on end of index; wasting of thenar muscles. *Electric.*—Galvanic response only in abductor and opponens pollicis. *X ray.*—Shows a small foreign body in lower third of forearm. Lesion diagnosed as partial one.

Expectant treatment tried till Jan. 29, 1919, i.e., massage, galvanism, strapping to keep thumb opposed; but no improvement.

Operation, Jan. 29, by Dr. Forrester-Brown.—Suture of left median in forearm. Median invaded by scar, and adherent to the deep aspect of radial head of sublimis, in which, in a nodule of scar, lay the foreign body. A few fibres ran down the posterior aspect of the nerve; no faradic response. An inch and a half resected till healthy bundles reached. Sutured with wrist in straight line and elbow a little flexed. Primary healing.

Progress.—Feb. 14.—Hot soaks, massage, and galvanism begun. Feb. 21.—*Sensory*: Return of joint sense. No distal tingling. *Motor*: Still paralysis of abductor pollicis; can oppose thumb—? how. March 21.—*Sensory*: Pressure now felt; prick felt on palm; wool felt on parts of index and thumb. Wrist extends well. Began farm work. March 28.—*Sensory*: Wool not correctly localized; prick felt except at tip of index. *Motor*: Can now abduct thumb. *Electric*: Faradic response in abductor and opponens. *Trophic*: No ulcer now, though he touched finger with a cigarette. March 31.—No anæsthesia. Normal thumb movements. Confirmed by Colonel Stiles. July.—Re-enlisted.

Case 6.—**Musculospiral freed from callus. Recovery, although no response to faradism at operation.**

Pte. B., age 34. Admitted to Edinburgh War Hospital, Jan. 22, 1919. Gunshot wound of chest, and left fractured humerus, July 29, 1918. Wrist-drop. Healed Feb. 22, 1919.

On Admission.—*Joints.*—Shoulder movements a little limited. *Motor.*—Paralysis of musculospiral except triceps and twitch in extensor communis. There seems a little tone in radial and thumb extensors. *Sensory.*—Radial anæsthesia to wool and prick. Slight neuralgia. Tenderness of supinator longus and extensors. *Trophic.*—Much wasting of extensors. *Electrical.*—Diagnosis of incomplete lesion of the nerve, probably compression, by Capt. McDonald, because faint faradic response in thumb and finger extensors, which was immediately overcome by their opponents contracting. Slow galvanic response in extensor carpi radialis longior (A.C.C. greatest). No response in supinator longus or extensor carpi radialis brevior.

Operation, Feb. 5, by Dr. Forrester-Brown.—Musculospiral nerve freed from callus. Nerve found to have S twist round spur of callus; nerve thick, hard; but no faradic response except in triceps and supinator longus. Spur of bone removed, and raw surface covered with flap of triceps. Nerve freed and incised longitudinally in several places. Long cock-up splint. Primary healing.

Progress.—Massage and galvanism begun. Feb. 24.—Apparently tone in extensors of wrist. Away six weeks at auxiliary hospital, where treatment was continued. April 28.—Can hold wrist dorsiflexed and extend it in mid-supination. Tone in extensors of knuckles. Extensors filling out. May 8.—Thumb and knuckle extensors just act. May 19.—Seen by Colonel Stiles, who found all extensors acting. May 29.—Can keep wrist dorsiflexed while gripping. June 13.—Can dorsiflex wrist a little against gravity when fingers are flexed. July 11.—Wrist still falls to a straight line when knuckles are extended. November.—Good use of all extensors: grip fairly strong. December.—Discharged for light work.

AN OPERATION FOR THE CHRONIC DISLOCATION OF THE PERONEAL TENDONS.

By R. E. KELLY, Liverpool.

The work of Albee has shown to what an infinite variety of conditions a bone graft may be adapted. His treatment of Pott's disease by the bony fixation of the spinous processes, his inlay graft for fracture of the patella, his treatment of talipes varus by inserting a wedge of cuboid into the split and separated halves of the scaphoid, his deepening of the acetabulum in congenital dislocation of the hip, are a few examples of the work of the cabinet-maker turned surgeon.

It occurred to me that a bone graft might be used to prevent the chronic dislocation forwards of the peroneal tendons out of their groove in the fibula. This condition, though rare, is both painful and disabling. I did an operation of this type about twelve months ago on a sergeant in Salonika. A few weeks since I received a letter from him saying that he had had no further dislocation, and that he was quite pleased with the result.

The steps in the operation were as follows:—

A hockey-stick-shaped incision was made behind and below the external malleolus. A skin flap was then turned forwards, and the whole of the external malleolus and the

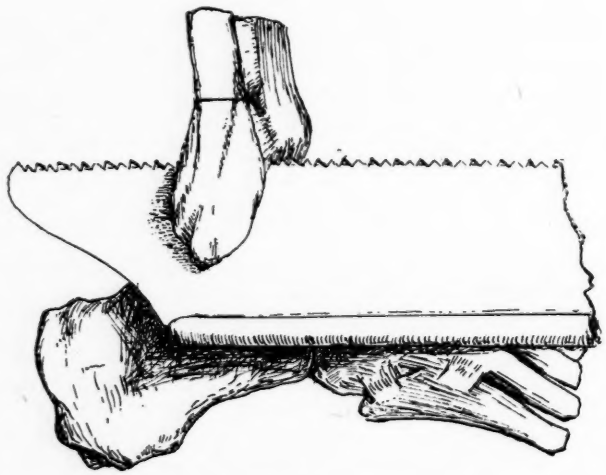

Fig. 403.—Veneer graft for deepening peroneal groove.

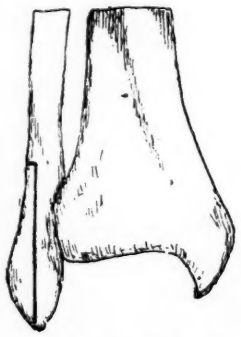

Fig. 404.—Saw-cuts in external malleolus for veneer graft.

tendons were exposed. In front of the tendons the periosteum was incised vertically, and with a raspatory the whole of the external surface of the fibula was exposed and bared for about 2 inches. Posteriorly the periosteum carried with it the displaced tendons, and care was taken, by keeping close to the bone, not to enter the tendon sheaths. The latter, with the periosteum, were then strongly retracted backwards and inwards.

By means of two saw-cuts, one in the sagittal plane and the second in a horizontal plane, the last inch of the subcutaneous surface of the fibula was resected, and formed a veneer-like graft almost wholly composed of compact bone tissue (*Figs.* 403 and 404).

This small graft was displaced directly backwards for about ¼ inch so as to form a prominent lip to the peroneal groove. It was fixed in its new position by two countersunk screws (*Fig.* 405). The screws, of course, did not penetrate to the ankle-joint. I found it an advantage to displace the graft obliquely. The screws were inserted as near as possible to the compact tissue of the bed in order to ensure a good bite, and I made sure that the line of the screws coincided with what would be the greatest outward thrust of the tendons. Firmly fixed in this way, the graft formed a new lip to the peroneal groove, and effectively prevented the tendons from slipping forwards. The periosteum was now allowed to fall back into position. Its anterior flap covered the raw bony surface of the bed, and the posterior flap formed a perfect barrier between the overhang of the graft and the tendon sheaths. The skin was sutured, the foot placed in an extended position, and a plaster-of-Paris bandage applied. This was removed at the end of five weeks. Active movement and some massage followed.

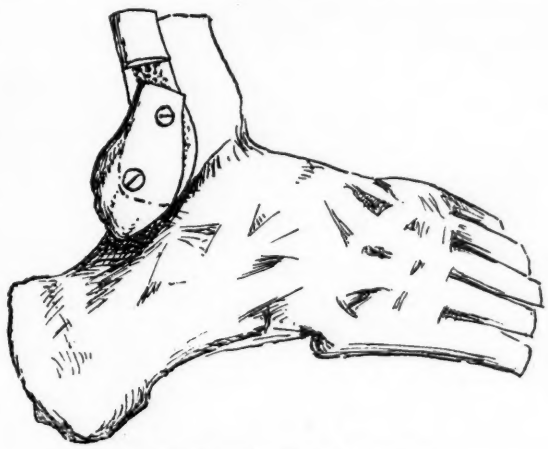

FIG. 405.—Veneer graft fixed by screws.

Though the result was satisfactory, the obvious criticism to an operation of this kind is the presence of screws so near the ankle-joint. I have obviated this difficulty by cutting the graft in a different way. *Figs.* 406 and 407 make the method clear.

The periosteum and tendons having been well retracted, a small drill-hole (*Fig.* 406, O) is made in the fibula. This drill-hole is in the vertical plane, is rather nearer the outer than the inner edge of the fibula, and runs from the front directly backwards and somewhat downwards. From this drill-hole a vertical saw-cut is made downwards, but stops

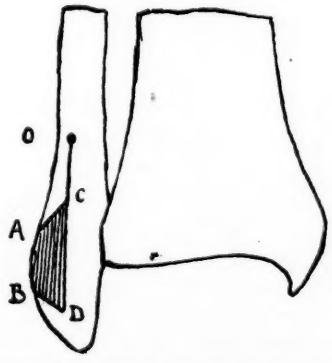

FIG. 406.—Saw-cuts in external malleolus for dovetail graft. O = drill-hole.

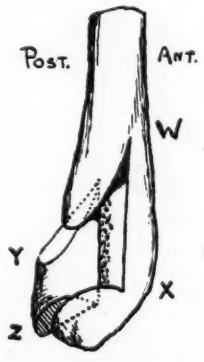

FIG. 407.—Outer surface of external malleolus, showing dovetail graft.

short of the lower end of the malleolus at the point D (*Fig.* 406). I had thought I could do this with a Gigli saw, but soon found that a much better tool for the purpose was a very fine finger saw. It was what a cabinet-maker would call a fine keyhole saw, and made a saw-cut less than half a millimetre in thickness.

Two other saw-cuts, both oblique, will free the graft. They are made in such a way that the graft is undercut and wedge-shaped; that is to say that the line A B is less than C D (*Fig.* 406), and Y Z is less than W X (*Fig.* 407). The graft is therefore thinner exter-

nally and posteriorly. As soon as the saw-cuts meet, the graft is loose and is separated from its bed by the thickness of the saw-cut all round. From its shape, however, it will fit tightly in its bed if it is moved backwards. The amount of displacement is of course dependent on the obliquity of the saw-cuts and their thickness. They should be so fashioned that the graft, when hammered backwards, fits tightly in such a position that the overhang of the graft posteriorly is about $\frac{1}{4}$ inch. This is sufficient to keep the tendons in place, and to prevent their displacement forwards. A graft of this kind does not

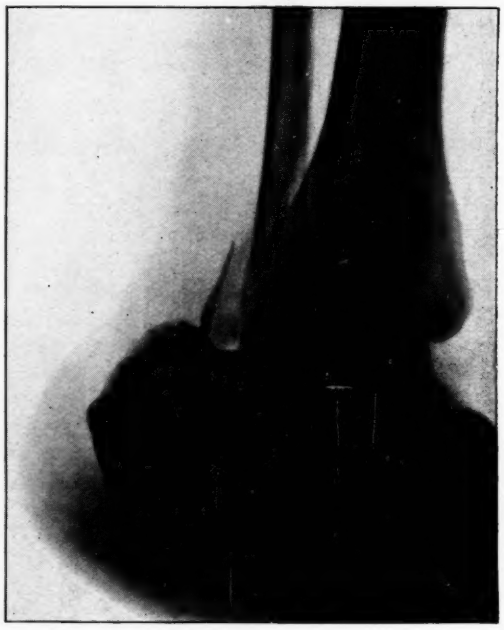

FIG. 408.—Condition after dovetail operation.

require any screws or pegs to keep it in position, and it cannot be displaced by the tendons owing to its dovetail shape.

Four months ago I did this operation on a blind patient in whom the condition was very distressing owing to the fact that he was unable to avoid uneven ground, and in whom the dislocation of the tendons occurred whenever he dorsiflexed his ankle past a right angle. *Fig.* 408 shows the *x*-ray of the condition after operation. The result is eminently satisfactory. He has had no further dislocation of the tendons, and the ankle movements are normal.

THE CRUCIAL LIGAMENTS OF THE KNEE-JOINT: THEIR FUNCTION, RUPTURE, AND THE OPERATIVE TREATMENT OF THE SAME.

By ERNEST W. HEY GROVES, Bristol.

The crucial ligaments of the knee have hitherto been the subject of morphological rather than of clinical interest, and their rupture has not been recognized as a definite entity in most surgical text-books.

It is probable that ruptured crucials have been often overlooked, owing to the common method of surgical approach to the knee-joint by a small opening over the internal cartilage. Unfortunately, every variety of internal derangement of the knee is often regarded as merely a 'slipped cartilage,' and a removal of the meniscus has become a routine treatment for all such cases, whether the cartilage shows any morbid condition or not. It would seem to be a wiser practice to investigate the condition of the joint thoroughly by turning up the patella in every doubtful case; and if this is done, various conditions will be revealed which otherwise escape both notice and treatment. Among such conditions are loose bodies, synovial fringes, fractures of the spine of the tibia, and rupture of the crucial ligaments. Probably the great majority of cases of internal derangement of the knee can be accurately diagnosed before operation; but it is just in those cases where the cause of derangement is doubtful that complete operative exposure is of such value.

Isolated cases of rupture of the crucial ligaments have been reported from time to time. Mayo Robson appears to have been the first to undertake an operation for relief of this condition, though Battle was the first to publish an account of such an operation. In these cases, and that of Pringle, it is simply stated that the torn ligaments were repaired by suture. I confess that I find it difficult to understand these statements, because in all my cases the ligaments have been so destroyed, or torn out from their bony attachments, that direct suture would have been utterly impossible. Goetjes has collected all reported cases of this injury up to 1913, and they number only 30, including 7 which he himself had observed. Of these cases, only 12 were subjected to open operation; in 5 an attempt was made to effect the repair of the torn ligaments, and in 5 the operation consisted in the removal of a fragment of bone torn off by the ligament.

Sir Robert Jones with Alwyn Smith (1913) has described a number of cases of fracture of the spine of the tibia, some of which were associated with rupture of the crucials. But these authors do not in this paper advocate suture or repair of the ligaments. In 1917 I described an operation for the substitution of torn crucial ligaments by fascia or tendons, and in 1918 Alwyn Smith reported several cases of rupture of the anterior crucial ligament in which he had employed a modified form of the operation which I had described.

The War has, however, made the accident comparatively common, and one which can be recognized with considerable certainty, even before the knee-joint has been opened.

In the last three years no less than 14 proved cases have come under my own observation and treatment, only two of which were specially sent to me from a distance, the remainder being all numbered among the patients of the Special Military Surgical Hospital at Bristol.

In 1917 I first operated upon this condition, using the iliotibial band to replace the lost anterior crucial, and a note of this operation was published in *The Lancet*. Since then 13 other cases have afforded material for further observation, the subject of the present paper.

Anatomy and Physiology.—The anterior crucial ligament (*Fig.* 409) is attached above to the outer condyle of the femur, far back in the intercondylar notch. Its direction is downwards, forwards, and a little inwards to its attachment in front of the spine of the tibia. The forward direction of the anterior ligament makes it a check upon the forward movement of the tibia upon the femur which takes place during extension. It is made tense by extension of the knee.

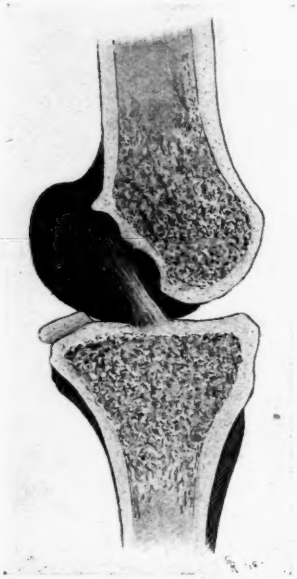

FIG. 409.—Anterior crucial ligament seen in sagittal section of the knee-joint. Tense in extension.

The posterior crucial ligament (*Figs.* 410, 411) is attached above to the front part of the intercondylar notch on its inner aspect. Its direction is downwards, backwards, and a little outwards, and it is attached to the back of the articular surface of the tibia. The backward direction of the posterior crucial makes it a check upon the posterior displacement of the tibia which occurs during flexion. It is made tense by flexion of the knee.

FIG. 410.—Posterior crucial ligament, seen in sagittal section of the knee-joint. Tense in flexion.

Both ligaments, owing to their oblique direction, act as checks to internal rotation of the leg upon the thigh, the anterior running forwards and inwards to the front of the tibia, the posterior running backwards and outwards to the back of the tibia. Thus both ligaments will be made tense by internal rotation of the leg.

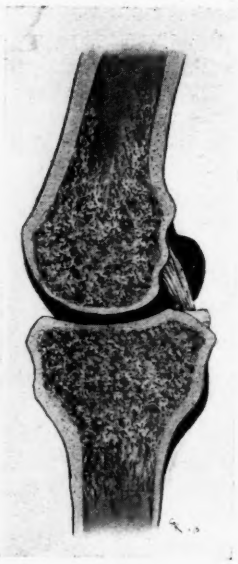

FIG. 411.—Posterior crucial ligament, seen in sagittal section of the knee-joint, relaxed in extension.

Of these well-known facts it is especially necessary to emphasize the obliquity of both crucial ligaments in the sagittal plane, because it is this obliquity which gives them their most important function, viz., the checking of forward displacement of the tibia by the anterior, and of backward displacement by the posterior, ligament. There is no other structure in the knee-joint which serves as a check to this forward or backward displacement. The lateral ligaments (*Fig.* 412) have a vertical direction, and will, in the absence of the crucials, allow of the tibia being displaced forwards or backwards. The posterior ligament of Winslow can only act as a check when it is tense, i.e., during extension of the joint, whereas the posterior crucial exerts its check action when the knee is bent.

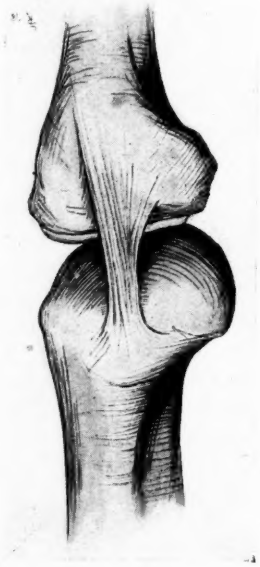

FIG. 412.—Internal lateral ligament of the knee-joint. Note the vertical direction of the ligament, which makes it unable to control backward or forward displacement of the tibia on the femur.

The importance of recognizing the check action of the crucial ligaments as being dependent upon their oblique direction, has a definite relation to the operation proposed for their repair. Any new ligament which is used to replace them should be given this oblique direction, even in an exaggerated degree, because an anterior ligament will be efficient in preventing anterior tibia displacement in proportion to its anterior obliquity, and a posterior ligament will prevent posterior displacement by its posterior obliquity. It is this consideration which justifies the wide exposure of the interior of the joint so as to place the new ligament in the best line, in contradistinction to a mere passage of new ligaments across the joint without opening its interior.

Causes of Rupture.—In all my cases the injury was a very severe one, usually of such a kind as might have caused an actual dislocation of the knee. Most of the men received the injury by a shell explosion, which either knocked them down or caused them

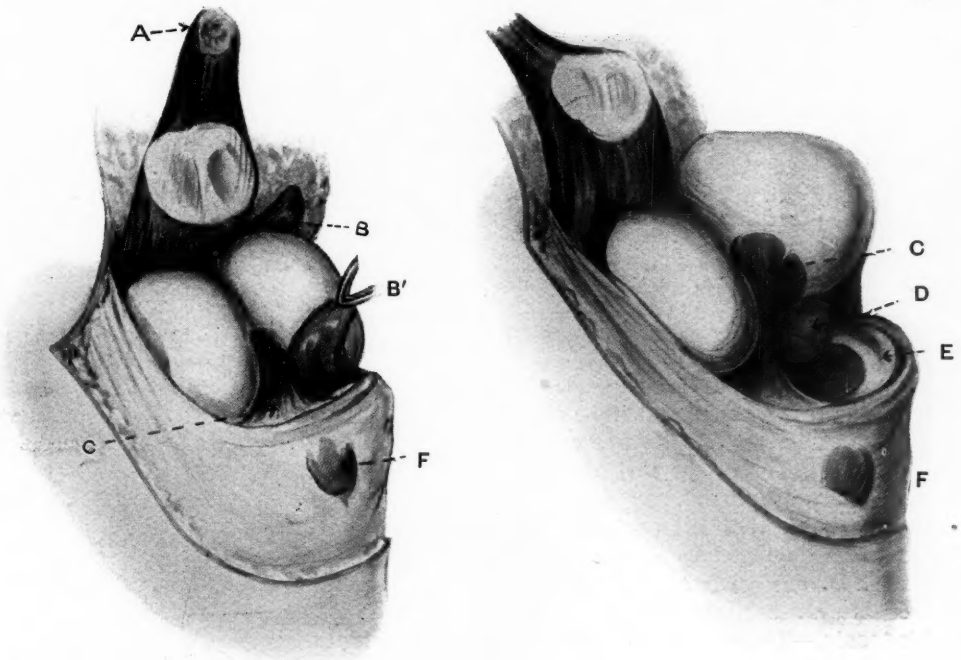

FIG. 413.—A knee-joint showing complete rupture of the posterior crucial and internal lateral ligaments and partial rupture of the anterior crucial. **A**, Tubercle of tibia turned upwards. **B**, Upper torn end of internal lateral ligament. **B'**, Lower end of torn internal lateral ligament, which had become turned inwards into the knee-joint. **C**, Partially torn anterior crucial ligament. **D**, Tibial end of the posterior crucial ligament enlarged as a fibrous knob. **E**, Internal semilunar cartilage. **F**, Area of tibia from which tubercle has been chipped off.

to be buried. In two cases the injury seemed to have been sustained in two stages, i.e., the patient was knocked down and suffered from 'a sprained knee'; he wore a splint and rested for some time; then soon after going on duty he received another injury to the knee, after which the signs typical of crucial destruction appeared. In almost all cases the circumstances of the accident were such that the patient could give no clear account of the exact position of his leg at the time, nor of the direction of the blow. But in comparison with the common type of torn semilunar cartilage, the crucial ligament injuries present a broad contrast in the matter of causation.

Injuries to the meniscus are caused by indirect violence of a twisting character, the accident often being comparatively trivial in its appearance to the onlooker. Those of the crucial ligaments are caused by severe direct injury, the accident being of a grave spectacular character.

Morbid Anatomy.—In the present series of 14 cases the anterior ligament alone was torn in 10, the posterior alone in 2, and both were torn in 2. As regards the site and extent of the lesion, it is difficult to be precise, because the operation was usually done so long after the injury. In not one single case was there any evidence, either by *x* rays or at the operation, of a bone injury in the nature of the tearing off of a flake of bone from either the femur or the tibia. In most cases it looked as though the ligament had been torn from its attachment to the femur. Usually it was represented only by a few shreds, the chief bulk of the torn ligament having disappeared. Thus it would be quite impracticable to attempt a direct suture of the ligament, because there is little or nothing to lay hold of.

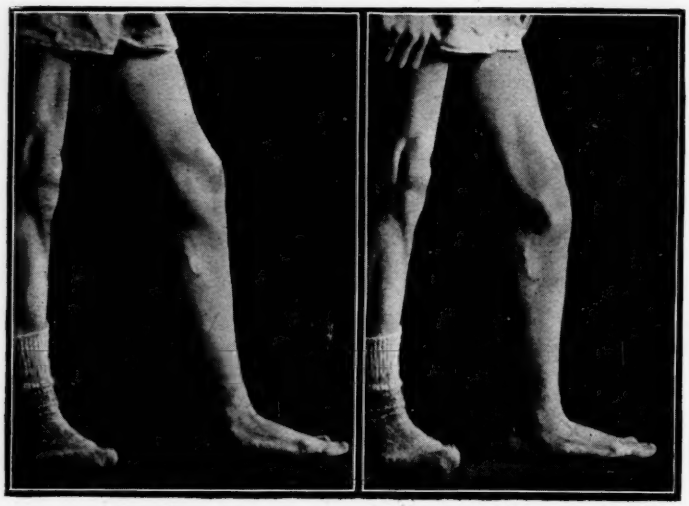

FIG. 414.—Rupture of the anterior crucial ligament, showing the subluxation forwards of the tibia. A, Normal position. B, Subluxation of tibia forwards.

In about one-half of all the cases there was coincident damage to the internal lateral ligament. In one case this was torn right across, and its free end lay inside the knee-joint (*Fig.* 413), but in the rest the rupture of the lateral ligament was only partial.

It is probable that the posterior ligament of the knee-joint is often damaged in association with injuries of the crucials; but only in one of my cases was there marked genu recurvatum indicating such a lesion.

Diagnosis.—The diagnosis of the nature of the lesion in rupture of the crucial is a matter of considerable certainty, as is demonstrated by the fact that in every one of the present series the diagnosis made beforehand of the rupture, and of whether it affected the anterior, posterior, or both ligaments, was proved to be correct at the time of operation. There have been no cases in which the diagnosis has been made, and then proved to be incorrect on direct exposure of the structures.

Symptoms of Anterior Crucial Injury.—On passive manipulation, the head of the tibia can be moved forwards on the femur. In active exercise, when the foot is put forward and the weight of the body pressed on the leg, then the tibia slips forwards. Sometimes this forward slipping of the tibia occurs abruptly with a jerk; often it is under the patient's control, as in the case shown in *Figs.* 414, 415. This man could walk deliberately quite well, but if he hurried or forgot to control his knee, the subluxation would suddenly occur, giving him a sense of insecurity, or actually throwing him down.

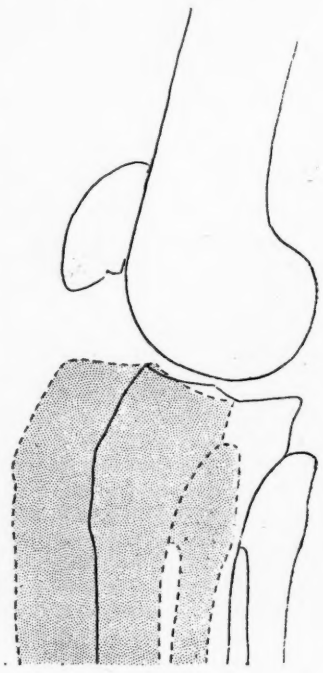

FIG. 415.—Drawing constructed by superposition of two *x* rays from the case seen in *Fig.* 414, showing the extent of forward displacement of the tibia (shaded) possible when the anterior crucial ligament is missing.

Symptoms of Posterior Crucial Injury.—On passive manipulation, the head of the tibia can be displaced backwards on the femur. On walking, at the end of the step when the leg is just about to be raised from the ground, the posterior displacement occurs (*Figs.* 416, 417).

Rupture of Both Crucials.—This injury, which is usually associated with a tearing of the posterior or lateral ligaments, produces a variety of flail knee. The patient cannot walk at all, unless his leg is encased in a cage-splint. The tibia slips forwards or backwards on the femur, when moved by passive or active force.

Original Plan of Operative Treatment.—When I first operated upon these cases in 1917,

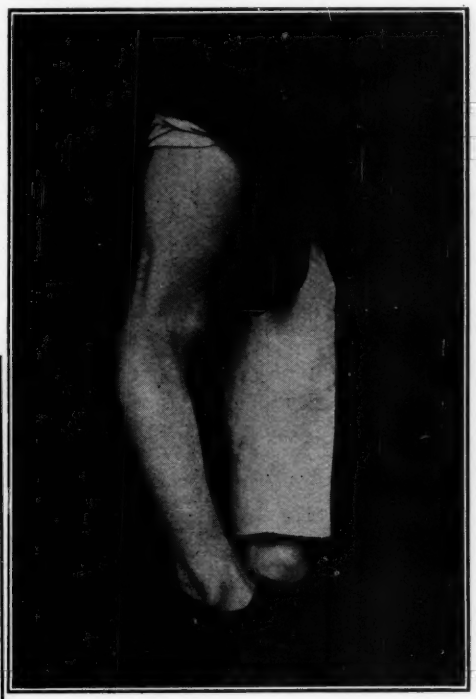

FIG. 416.—Photograph of a boy, age 14, with rupture of the posterior crucial ligament, showing the typical backward displacement of the tibia. (Forbes Fraser's case.)

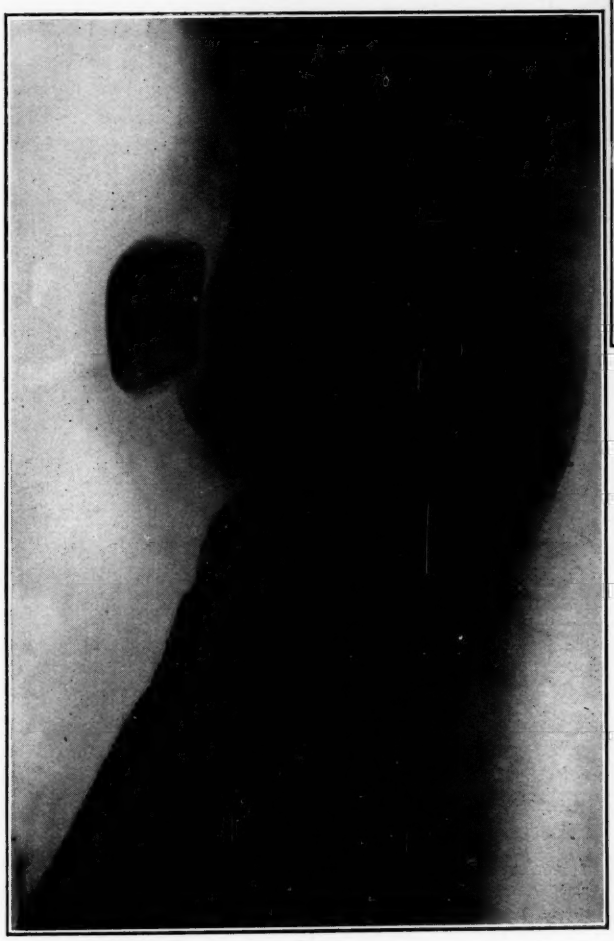

FIG. 417.—Skiagram of the case seen in *Fig.* 416, showing the backward displacement of the tibia.

I used the iliotibial band as a substitute for the anterior crucial, and the semitendinosus tendon for the posterior, cutting each of these structures from their attachments to the tibia and then threading them through the knee-joint. But after doing this in the earlier cases, two facts made themselves clear: (1) That when the lower end of the fascia or tendon was cut, the length of such structure was very limited, and made a real difficulty, because it allowed no spare tissue for manipulation; and (2) This technique deprived the already weakened knee of one of its lateral supports, that of the iliotibial band being especially important.

Present Operation for Ruptured Anterior Crucial.—The leg is encased in sterile stockingette. No tourniquet is used. A large U-shaped incision is made in front of the knee, the lowest part of the incision being just below the tubercle of the tibia. The

inner limb of the U runs along the line of the inner hamstrings, whilst the outer limb is about one finger-breadth on the outer side of the patella. The incision in the stockingette is fastened to the skin edges by Michel's clips. The tubercle of the tibia is chiselled off, taking a generous chip of bone about $\frac{3}{4}$ in. square and $\frac{1}{2}$ in. thick. The patella is turned upwards after cutting through the capsule and synovial membrane of the joint. Special care should be taken not to injure the iliotibial band on the outer aspect of the joint.

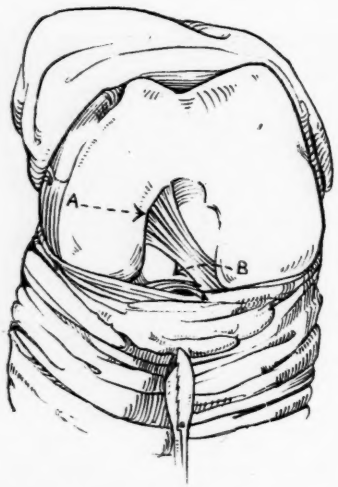

FIG. 418.—Typical rupture of anterior crucial ligament (B), the posterior ligament (A) being intact.

The knee is now flexed. Usually the reflection of the synovial membrane which clothes the front of both crucial ligaments is intact, but on reflecting this the absence or rupture of one or both crucials becomes at once apparent (*Fig.* 418).

The iliotibial band is now defined by prolonging the outer limb of the original incision (*Fig.* 419) upwards, and a strip 8 in. long and $1\frac{1}{2}$ in. wide is separated by two longitudinal incisions and one transverse one, the band retaining its original attachment to the head of the tibia.

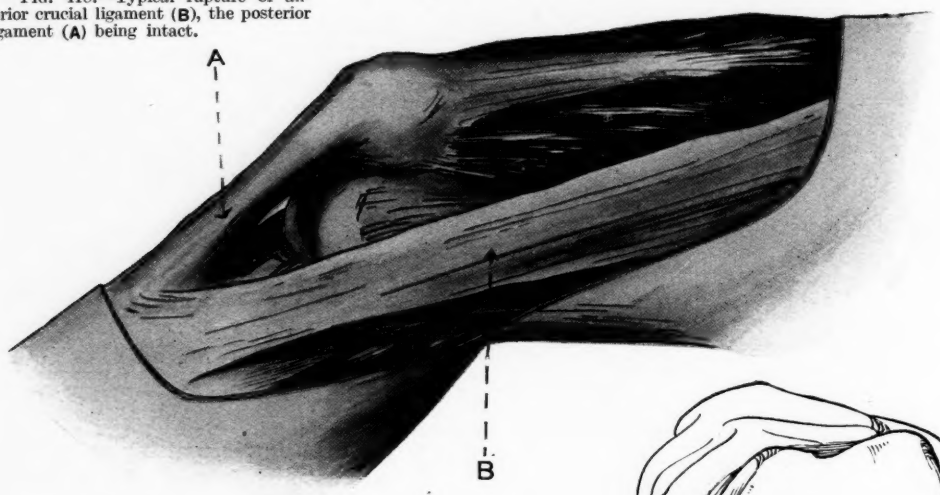

FIG. 419.—Dissection of the outer aspect of the knee-joint. The strongest part of the iliotibial band of fascia (B) has been defined. A, Ligamentum patellæ.

The external condyle of the femur is drilled by means of twist drills, using at first $\frac{1}{4}$-in. then $\frac{5}{16}$-in., and lastly $\frac{3}{8}$-in. sizes. The inner end of the hole thus made should be as far back on the outer aspect of the intercondylar notch as can be arranged, so as to make the new ligament as oblique as possible in a sagittal plane (*Fig.* 420).

The front part of the tibia is then drilled in a similar way (*Fig.* 421), so that the inner end of the hole lies just in front of the tibial spine, and the external orifice is over the most prominent part of the inner tuberosity of the tibia. After boring each hole, a strand of gauze is passed through and made to clear

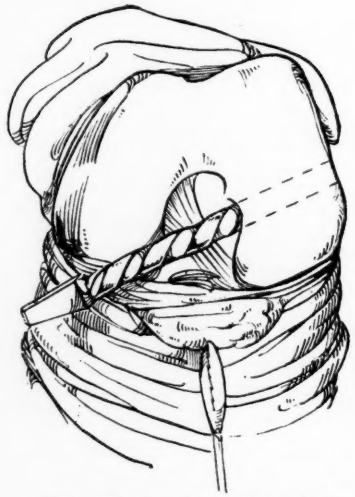

FIG. 420.—Repair of the anterior crucial. A tunnel is being made from within outwards, through the external condyle of the femur. The inner opening of this tunnel corresponds to the position of the femoral attachment of the ligament.

away any bone débris. It is important that the proximal end of each canal—viz., that on the outer aspect of the femur and that on the articular surface of the tibia—should have the edges bevelled off by a gouge, so as to make a smooth, funnel-shaped orifice.

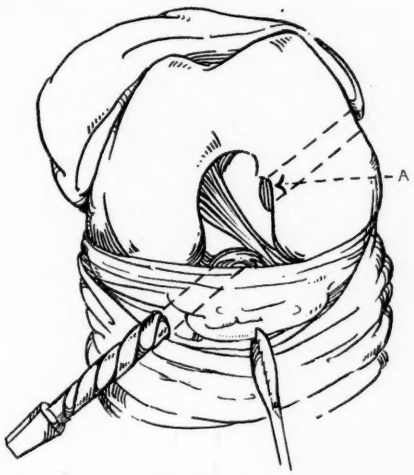

FIG. 421.—Repair of the anterior crucial. A tunnel is being made through the internal tuberosity of the tibia. The inner opening of this tunnel corresponds to the position of the tibial attachment of the ligament.

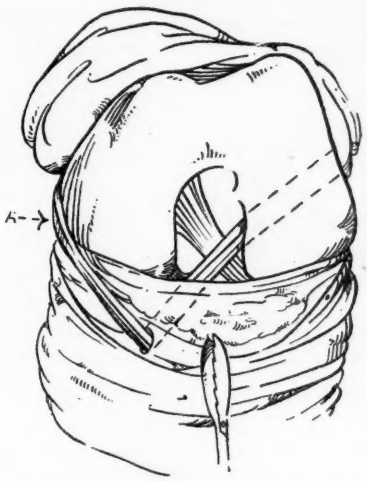

FIG. 422.—Repair of the anterior crucial ligament. The iliotibial band has been drawn through the external femoral condyle, the knee-joint, and internal tibial tuberosity, and then turned upwards to supplement the internal lateral ligament (A).

A wide strip of ribbon gauze is then used as a pilot. It is passed from inside the joint through the hole in the condyle, and its end is wrapped round the end of the strip from the iliotibial band and secured to this by a few stitches. The fascia is pulled through the femur, and then, using the same piece of gauze, through the head of the tibia. This leaves about 3 inches of free end projecting from the inner tuberosity of the tibia. Before this is attached, the knee is flexed and the new ligament pulled taut through both bones (*Figs.* 422, 423). The free end is then passed up to the most prominent point on the inner aspect of the internal condyle, and fixed by sutures and by one ivory nail. This latter step was suggested by Alwyn Smith, and it forms a valuable reinforcement to the internal lateral ligament. The capsule of the joint is sutured by a few interrupted catgut stitches. The tubercle of the tibia is fixed by two bone or ivory nails to its original bed. The skin is sutured by silkworm gut and clips.

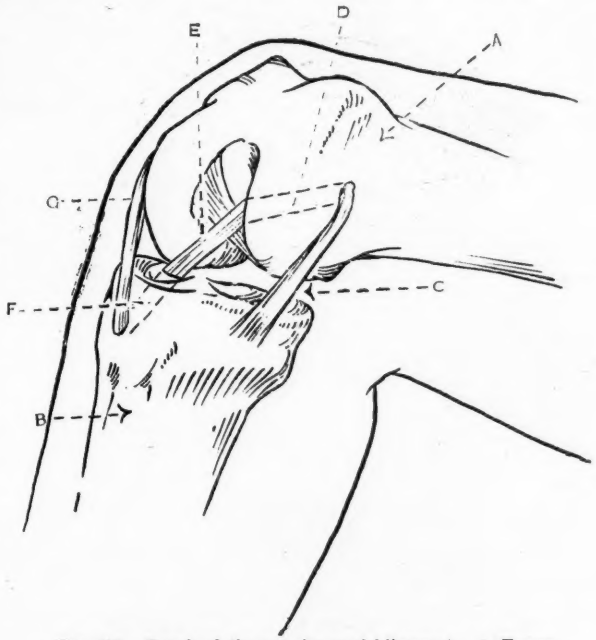

FIG. 423.—Repair of the anterior crucial ligament. **A**, Femur. **B**, Tibia. **C**, Iliotibial band. **D**, Tunnel in external condyle of femur. **E**, Intra-articular portion, forming new ligament. **F**, Tunnel in tibia. **G**, Terminal part of fascial band turned up to supplement the internal lateral ligament.

Present Operation for Ruptured Posterior Crucials.—The first stage of the operation up to the point of full exposure of the joint cavity is the same as above (*Fig.* 424). The diagnosis having been established, the inner limb of the U is lengthened until 6 inches of the hamstring tendons are exposed (*Fig.* 425). Corresponding lengths of both semitendinosus and gracilis tendons are cut, the distal ends being isolated and brought down, and the proximal ends sutured to the semimembranosus muscle.

A strong pair of artery forceps are then thrust backwards through the inner part of the posterior ligament of the knee, between the posterior horn of the meniscus and the head of the tibia. The two tendon strips are pulled forward by means of the forceps until their free ends hang out from the front of the joint. A hole is bored through the internal condyle of the femur in such a manner that it opens as far forward as possible on the inner aspect of the intercondylar notch (*Fig.* 426). The tendons are piloted through this hole by ribbon gauze, and, after the new ligament has been pulled tight whilst the knee is fully extended, the free ends are turned downwards and attached to the inner aspect of the inner tuberosity of the tibia (*Figs.* 427, 428). The joint is closed as before.

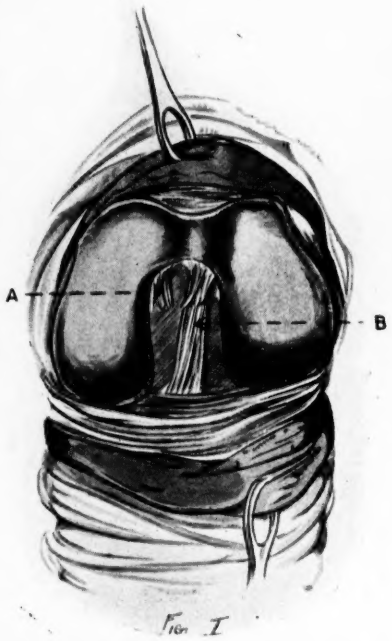

FIG. 424.—Typical rupture of the posterior crucial ligament (A). The anterior crucial (B) is intact.

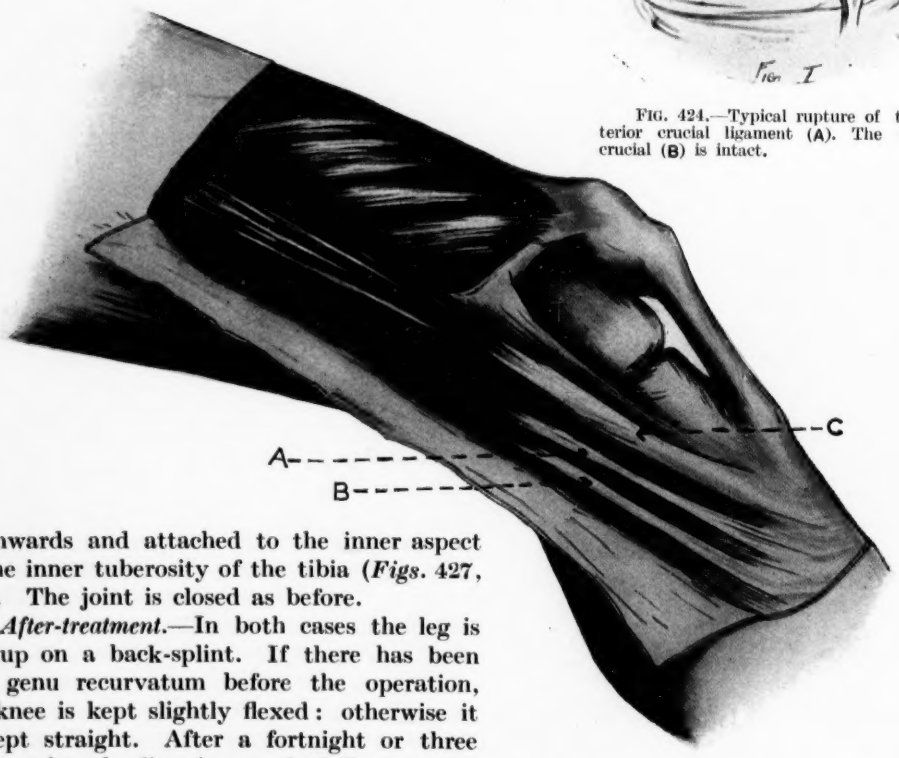

FIG. 425.—Dissection of the inner aspect of the knee, showing the relations of the sartorius (C), gracilis (A), and semitendinosus (B) tendons.

After-treatment.—In both cases the leg is put up on a back-splint. If there has been any genu recurvatum before the operation, the knee is kept slightly flexed: otherwise it is kept straight. After a fortnight or three weeks, when healing is sound, daily massage and faradism are applied to the quadriceps muscle. Six weeks after the operation the patient is put up in a light plaster case and allowed to walk. Then he is fitted with a moulded case provided with lateral hinges at the knee, and he uses this for three or six months as the case may be.

Alternative Suggestions.—By some surgeons the idea of a wide exposure of the interior of the knee-joint is regarded as objectionable, and the joint is either not opened

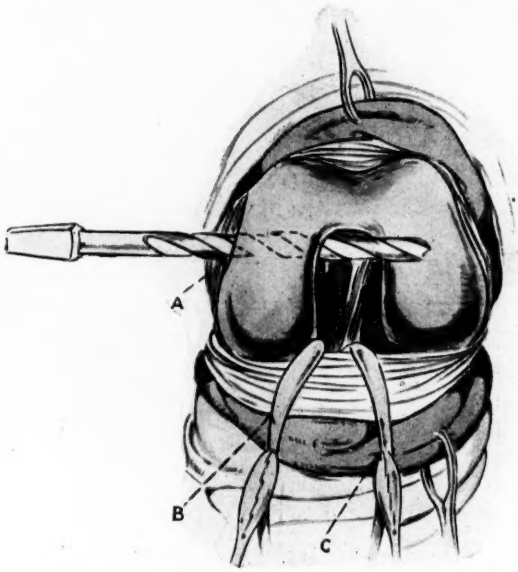

FIG. 426.—Repair of the posterior crucial ligament. A tunnel (A) is being drilled through the internal condyle of the femur. The tendons of the gracilis and semitendinosus (B and C) have been brought into the joint from the back.

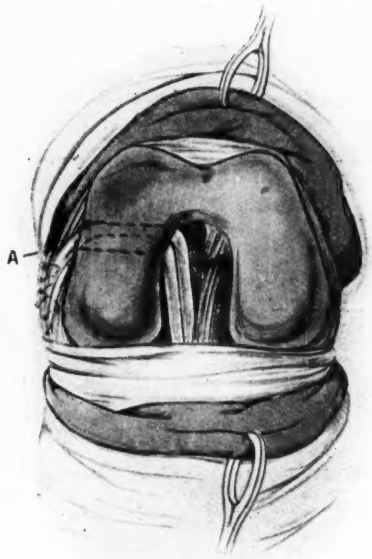

FIG. 427.—Repair of the posterior crucial ligament. The two tendons have been drawn through the tunnel in the internal femoral condyle and then turned downwards to supplement the internal lateral ligament.

at all (Trethowan), or merely exposed by vertically splitting the patella (Alwyn Smith). Then oblique holes are made from the inner tuberosity of the tibia upwards and outwards to the outer condyle of the femur, and from the outer tibial tuberosity to the inner condyle. Through these holes the new ligament is passed. Alwyn Smith uses the iliotibial band in the way I have described. Trethowan uses stout strands of twisted silk.

As regards this method of laying down the new ligament, there are several disadvantages. Chief among these is the impossibility of obtaining a correct or optimum line for the new ligament. Such can only pass straight upwards from the tibia to the femur, and the ligament viewed in a sagittal section would be vertical. But, as has been already pointed out, this is anatomically incorrect, and places the ligament at a mechanical disadvantage. The normal anterior crucial ligament runs obliquely downwards and forwards, and thereby has great power in preventing forward displacement of the tibia. It is true that the normal posterior crucial has a more vertical direction when the knee is extended, but when the knee is flexed the ligament becomes much more oblique, running downwards and backwards, and it is in this position that it comes into action. Therefore, if the operation is to be done at all, it would appear to me

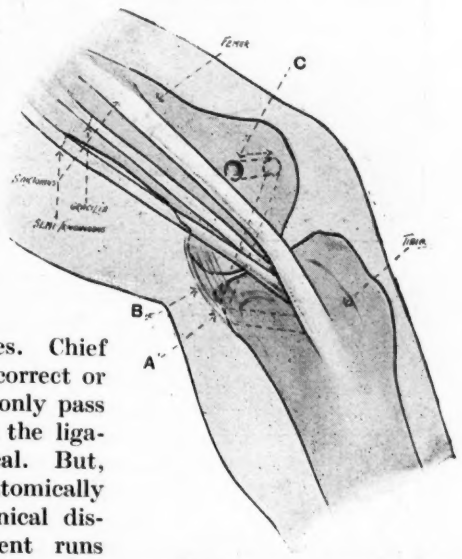

FIG. 428.—Inner aspect of the knee-joint, showing relations of the sartorius, gracilis, and semitendinosus tendons. A, The tendons of the gracilis and semitendinosus drawn backwards to the back of the joint. B, The posterior ligament of the joint through the tibial attachment of which the two tendons are drawn. C, The canal in the internal condyle of femur through which the two tendons are drawn. The dotted lines between A and C represent the new posterior crucial ligament.

to be well worth while to open the joint fully, and to lay the new ligament as obliquely as possible in relation to a sagittal plane.

I have never had any infection in a knee-joint exposed as described, nor have I ever seen any disadvantage follow from the separation and subsequent attachment of the tubercle of the tibia.

Results.—It is a matter of great regret that I cannot give a full account of the results of these operations. All the patients have been military, and after six months have passed from my own observation. Further, it is fair to observe that the full technique here described has only been elaborated and carried out in the later cases in the series, and I am sure that I could do much better with the earlier cases if I had to do them again. (*Figs.* 429, 430.)

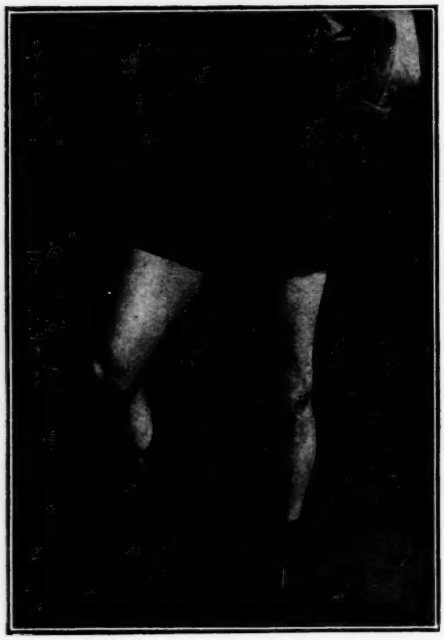

FIG. 429.—Repair of anterior crucial ligament six months after operation. Patient is standing with all his weight on the affected leg.

FIG. 430.—Repair of anterior crucial ligament. The affected leg is being held up in a flexed position.

Of the 14 cases operated upon, none were made worse by the operation; 4 cases showed no benefit—these included both cases where both the crucials were torn, and 2 cases of anterior crucial injury; 4 were benefited to some degree; 4 were cured to such an extent that the men could return to active service or carry out civil employment without wearing a splint; 2 were only operated on six months ago, and are still wearing their hinged leg irons; both promise to be successful. I hope to have an opportunity at the end of about five years of describing what are the ultimate results of these operations.

I am indebted to my colleague, Mr. Forbes Fraser, for the illustrations of his case, shown in *Figs.* 416 and 417; to Mrs. Trew for the drawings of *Figs.* 409, 410, 411, 412, 413, 419, 425; and to Miss D. Pillers for the remaining drawings. To each of these I give my most sincere thanks.

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THE TREATMENT OF TRIGEMINAL NEURALGIA BY THE INJECTION OF ALCOHOL INTO THE GASSERIAN GANGLION.

By H. H. RAYNER, Manchester.

This method of treatment was described by Härtel[1] in 1913, and has been practised in this country by a few neurologists as an alternative treatment to the injection of the nerve divisions as in Schlösser's method; the possibility of injecting the ganglion itself with alcohol is, however, not widely known amongst British surgeons; nor, I think, has any complete list of cases and results been published in this country.

The cases that I have treated in this way are too few in number, and sufficient time has not elapsed since the injection, to permit of any generalizations as to the comparative value of the method; but even with these limitations, a frank statement of one's personal experience may be of interest to surgeons and neurologists—a statement that includes every case, without any reservations, in which the method has been tried.

Technique.—Härtel's method has been closely followed; this may be described briefly as aiming at direct injection into the Gasserian ganglion through a needle which, entering the lower part of the face at a puncture in the cheek near the angle of the mouth, passes backwards, upwards, and slightly inwards between the mandible and superior maxilla into the foramen ovale; the needle is then passed through the foramen, and the injection made at a point 1 to 1½ cm. beyond the entrance to the foramen; great care must be taken never to exceed the distance of 1½ cm. from the point where the needle is felt to enter the foramen. Härtel's description must be consulted, and each step carefully checked in practice on the cadaver, by anyone desirous of attempting the method; but a few remarks suggested by my own experience may be added.

That it is possible to puncture and inject the ganglion and produce a destructive lesion of varying degree and extent in the ganglion cannot be doubted, though it may not be possible to do this at the first attempt. In the series of 20 cases on which this paper is based, definite sensory changes ranging from impairment of sensation to total anæsthesia of the entire trigeminal area were produced in at least 16, and in each of the cases of true epileptiform neuralgia, 18 in number, the shortest period of complete relief of pain was six months. The cases which showed no sensory change after the injection were the ones that relapsed after a period of six or seven months' immunity.

Obviously, success in the art of puncturing the ganglion must depend on the experience of the operator and his appreciation of the anatomical conditions; a mere passage of the foramen ovale by the needle must not be taken to mean that the ganglion will necessarily be reached by simply driving the needle onwards for 1½ cm.; a needle passed in an axis nearer to the vertical than that described by Härtel may readily enter the foramen, but is unlikely to reach the ganglion; more probably it will enter the subdural space. A more serious objection to the method than the difficulty and uncertainty in reaching the ganglion, for these can be largely overcome by practice, lies in the inability of the operator to restrict, with any precision, the action of the alcohol to a particular part of the ganglion; to produce a physiological destruction of the entire ganglion is to expose the patient to the same risk of trophic disturbances in the eye as does operative excision of the entire ganglion. To some extent it seems possible to localize the action of the alcohol by regulating exactly the position of the injection in relation to the foramen ovale according to the part of the ganglion responsible for the disease, and also by varying the amount of alcohol to be injected. If, for instance, it is desired to spare the ophthalmic portion of the ganglion—and in the majority of cases the ophthalmic area is not affected—

the point of the needle must not be passed more than 1 cm. through the foramen, and the injection should be made at several points within this distance; the total amount of alcohol should not exceed 1 c.c.

In all cases that show total anæsthesia of the ophthalmic division area twenty-four hours after the injection, the same precautions—protection of the eye by dust-proof goggle or suture of the lids—must be instituted immediately for the preservation of the cornea as after operative removal of the entire ganglion.

In my 20 cases, total anæsthesia of the entire trigeminal area was produced in 6, 2 of which developed trophic corneal ulceration; of these two, one had slight ulceration followed by good recovery, and the other severe ulceration terminating in a dense opacity in the centre of the cornea.

No other ill effects than the ocular ones were encountered in this series, but a consideration of the anatomical relations of the needle in its passage to the ganglion must impress one with the possibility of damage to important structures, intra- and extracranial.

Anæsthetic.—A general anæsthetic was given in the majority of my cases; in the others, novocain 1 per cent solution was injected along the needle track and into the ganglion before the alcohol; the latter method is preferable if the foramen can be recognized and entered without delay, and with patients who have a certain amount of self-control, as it affords the opportunity to observe the development of anæsthesia during the injection.

Results.—The results of treatment can be indicated most conveniently by grouping the cases according to the length of time that has elapsed since the injection.

A. Eighteen Cases of Epileptiform Neuralgia.—

3 *Cases injected more than two years :—*
- 1 case, the first to be treated by the method, relapsed after six months' freedom; was re-injected fifteen months ago, and has since been free.
- 2 cases have been entirely free from neuralgia since.

5 *Cases injected more than* 1 *year :—*
- 1 relapsed after six months' freedom.
- 4 have remained entirely free from neuralgia.

6 *Cases injected more than six months :—*
- 1 has not been traced owing to faulty address.
- 1 had recurrence seven months after injection and at once sought re-injection.
- 3 have remained entirely free from neuralgia.
- 1 considers himself cured, but states that he has 'twitches' of pain in bicuspid area of the gum of upper jaw.

4 *Cases injected less than six months :—*
- All free from neuralgia.

B. Two Cases of Neuralgia of the 5th Nerve, of Non-epileptiform Character.—

Both these were young women, 18 and 20 years of age respectively, who complained of intense burning and throbbing pain in the entire trigeminal area; continuous pain, though fluctuating in severity; the cutaneous area showed extreme hyperæsthesia, and in one of them a well-marked flush with slight swelling of the affected cheek.

Both patients were referred to me by medical colleagues as urgently requiring operative or injection treatment, and though it was quite clear in each case that the disease was not epileptiform neuralgia, after some consideration and trial of other methods it was finally decided to inject the Gasserian ganglion.

Case 1.—L. D. Obtained no relief at all after the first few days following the injection; she showed, however, only slight sensory changes after the injection.

Case 2.—E. G. Obtained complete relief for two and a half months only; the pain then returned, and though it was as severe in character, it was not so persistent as before the injection. It is noteworthy that, although the pain returned several months since,

the trigeminal area is still anæsthetic. This was the patient alluded to previously, who developed severe corneal ulceration a week after injection, despite the utmost precautions, and there is now a marked corneal opacity.

My experience of these two cases, and the experience of others in apparently similar cases, has led me to conclude that the lesion in this uncommon type of neuralgia—sometimes described as causalgia of the 5th nerve—is in one of the neurons of the facial sensory tract above the Gasserian ganglion, and that treatment directed to the ganglion or to the tract below it must fail.

SERIES OF 18 CASES OF TRIGEMINAL NEURALGIA TREATED BY THE INJECTION OF ALCOHOL.

Patient: Sex, Age	Divisions affected and Duration	Previous Treatment	Date of Ganglion Injection, with Sensory Result 24 Hours Afterwards	Result, Nov., 1919
No. 1.—M. S. F., 54	2nd left; 3 years	Extraction of all teeth; alcohol injection of 2nd division once	July, 1917. No sensory change	Relief for six months, then gradual recurrence; re-injected July, 1918, and well since
No. 2.—E. B. M., 51	3rd left; 4 years	Resection of inferior dental and lingual nerves, April, 1917. Extraction of all teeth on left side	Oct., 1917. Anæsthesia of 3rd area	Complete freedom and not lost a day's work since injection
No. 3.—W. S. M., 56	2nd and 3rd (chiefly 2nd); 'for years'	Injection of 2nd and 3rd divisions: few weeks' relief only	Oct. 1917. Impaired sensation of 2nd and 3rd areas	Complete freedom from neuralgia
No. 4.—M. H. F., 53	2nd and 3rd, and 1st slightly; 2½ years	All teeth extracted	June, 1918. Anæsthesia of entire area	Complete and good health. Eye unaffected
No. 5.—M. T. F., 38	2nd and 3rd; 2 years	All teeth extracted: injection of 3rd division in 1917; recurred 3 months later	July, 1918. Slight impairment of sensation in 2nd and 3rd areas	Complete freedom and good health
No. 6.—E. O. F., 63	2nd left; 4 years	Not stated	July, 1918. Anæsthesia of entire area	Complete freedom from neuralgia. Eye unaffected
No. 7.—S. B. M., 50	2nd and 3rd right; 5 years	All teeth extracted	Sept., 1918. Anæsthesia of entire area	Complete freedom and in good health. Eye unaffected
No. 8,—W. L. M., 58	2nd	Not stated	Nov., 1918. No sensory change	Neuralgia returned in seven months, and is now as bad as ever
No. 9.—E. G. F., 52	2nd and 3rd	All teeth extracted. Intracranial resection of 2nd and 3rd divisions with recurrence 22 months afterwards	January, 1919. Impaired sensation over whole area	Complete freedom since
No. 10.—L. H. F., 54	2nd and 3rd right; 3 years	Repeated injections of 2nd and 3rd divisions	March, 1919. No sensory change	Neuralgia returned in October and re-injection performed, producing marked impairment of sensation of 2nd and 3rd areas

TRIGEMINAL NEURALGIA TREATED BY THE INJECTION OF ALCOHOL, *Contd.*

PATIENT: SEX, AGE	DIVISIONS AFFECTED AND DURATION	PREVIOUS TREATMENT	DATE OF GANGLION INJECTION, WITH SENSORY RESULT 24 HOURS AFTERWARDS	RESULT, NOV., 1919
No. 11.—M. S. F., 46	3rd right; 8 years	All teeth extracted	April, 1919. No sensory change	Not traced, owing to insufficient address
No. 12.—M. F. F, 67	2nd and 3rd	All teeth extracted	May, 1919. Anæsthesia of entire area. Corneal ulcer, which healed	Complete freedom and "eye much better, with good sight"
No. 13.—L. H. F, 72	1st and 2nd, and 3rd occasionally; 14 years	All teeth extracted	May, 1919. Anæsthesia of entire area	Complete freedom. Eye unaffected when seen some weeks after
No. 14.—J. H. M., 60	2nd; 4 years	All teeth extracted	May, 1919. Slight impairment of sensation	States he is free from neuralgia, but has slight twinges of pain at one spot in gum of upper jaw
No. 15.—D. H. F., 44	2nd and 3rd; 8 years	All teeth extracted	Aug., 1919. Anæsthesia of 3rd division	Free from neuralgia
No. 16.—M. L. F., 55	2nd and 3rd; 11 years	Intracranial resection of 2nd and 3rd divisions, with 20 months' freedom	Aug., 1919. Effect not stated	Complete freedom and good health
No. 17.—F. M. M., 60	2nd right; 7½ years	Injection of 2nd division. High-frequency current treatment	Nov., 1919. Slight sensory impairment	Freedom
No. 18. P. J. F., 52	2nd division, right; 5 years	Repeated injection of 2nd division	Nov., 1919. Total anæsthesia	Anæsthesia of entire area; eye unaffected, but as yet protected by lid suture

REFERENCE.

[1] HÄRTEL, *Archiv für klinische Chirurgie*, 1912, 193.

CYST OF THE COMMON BILE-DUCT.

By ADAMS A. McCONNELL, Dublin.

True cysts of the common bile-duct are rare, if we are to judge by the literature on the subject. Up to October, 1917, only thirty-five cases had been reported. As the diagnosis has never been made before operation, and as the operative treatment has not yielded good results, it seems important to place on record every case presenting this condition.

On May 12, 1916, a girl, age 11, was admitted into the Whitworth Hospital on account of progressive distention of the abdomen and abdominal pain. More than a year before admission the child experienced pain in the abdomen of such severity that she lay down and cried during attacks. Six months after the first attack of pain the abdomen began to swell, and steadily increased in size. The child got paler in colour, readily fatigued, and her appetite became poor. Slight transitory jaundice had been noticed on one occasion. With the exception of whooping-cough during infancy, she had been previously healthy. The parents were healthy and had had twelve children, of whom four died while 'teething,' and one was 'poisoned by a dose of bad whiskey.' Physical examination on admission showed the vascular, respiratory, and urinary systems to be normal. There was slight jaundice, and the abdomen was markedly distended, especially in the epigastric and right hypochondriac regions.

On palpation, a hard, irregular mass was felt in these regions. It extended into the right lumbar region, and its edge was palpable from the middle of the epigastrium towards the right anterior superior iliac spine, but its definition ceased at the right mammary plane. The tumour seemed to be continuous with the liver both on palpation and percussion, but respiratory mobility was absent. Blood examinations gave normal results. The stools were normal; choluria synchronized with icteric attacks, but in the intervals the urine was normal except for the presence of excess of urobilinogen, which was demonstrated with Ehrlich's solution of dimethyl-para-amino-benzaldehyde and hydrochloric acid. The anatomical relations of the mass, the intermittent jaundice, and the indications afforded by the excess of urobilinogen in the urine, suggested that the lesion was intimately related to the liver.

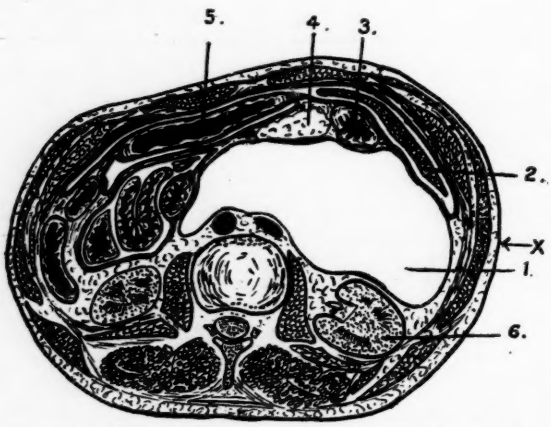

Fig. 431.—Cyst of common bile-duct. 1, Cyst; 2, Free edge of liver; 3, Duodenum; 4, Pancreas; 5, Stomach; 6, Right kidney. X, Needle introduced here. Level = L.V. 2.

At the request of Dr. Nesbitt I performed an exploratory laparotomy on May 26, 1916. The abdomen was opened by a vertical incision through the right rectus muscle. On opening the peritoneum, the duodenum and hepatic flexure presented in the wound, being pushed forward by a large tense cyst. The gall-bladder was independent of the cyst and was not distended. The liver was cirrhotic.

On further examination the cyst was seen to lie in the position indicated in the diagram (*Fig.* 431). It extended from the extreme right side of the abdomen to a point

some distance to the left of the middle line, and lay between the aorta, vena cava, and right kidney behind, and the pancreas and duodenum in front. It was obviously a retro-peritoneal cyst, and it was decided to aspirate its contents. To avoid contamination of the peritoneum an exploring needle was introduced at X in *Fig.* 431, and pure normal bile was removed. An incision was then made into the cyst and a finger introduced. The anatomical relations were verified, but it was impossible to reach the left extremity of the cyst, or visually to establish its communication with the proximal or distal portions of the common bile-duct. Over a pint of bile was evacuated, and a small drainage tube inserted. At the end of a week this tube was removed, and within two months the wound had closed. The patient's general condition was much improved, and there was no return of abdominal pain or distention when she left hospital in July, 1916.

In March, 1917, she returned with the following history: A fortnight before, the abdomen began to swell, and in a few days some leakage of bile took place at the original site of drainage. The wound evidently became infected, for when she was brought to hospital she was profoundly toxic, temperature 102°, pulse 120, and the abdomen was greatly distended, tense, and tender. The original wound was immediately opened, and a large quantity of pus mixed with bile evacuated. The whole cavity was washed out with eusol and drained. The patient made a rapid recovery, and the wound closed five weeks after the operation.

I did not see the patient again until October, 1918, when she came to hospital for examination at my request. The wound had remained healed, there was no return of abdominal pain or distention, and nothing definite was palpable in the abdomen, although there was slight fullness in the right hypochondrium. In March, 1919, the patient returned to hospital complaining of loss of appetite and occasional abdominal pain localized in the region of the gall-bladder. The physical signs were similar to those presented six months previously. I decided to perform a laparotomy in order to ascertain the condition of the cyst, and, if necessary, to make an anastomosis between it and the duodenum.

When the abdomen was opened, I was surprised to find that the cyst had shrunk to the size of a walnut, and occupied a position between the second stage of the duodenum and the right kidney. The cirrhotic process in the liver was more pronounced, but no other abnormality was encountered. As the patient had no jaundice, and as the cyst had contracted to such an extent, I did not perform an anastomosis, but closed the abdomen. The patient made an uneventful recovery. I saw her again in October, and her condition showed neither deterioration nor improvement. She still had occasional attacks of pain in the right hypochondrium, and the appetite was poor. She looked rather fat, but the appearance was due to excess of subcutaneous tissue rather than to a deposit of fat therein. She was mentally slow and apathetic. Her general appearance was suggestive of thyroid insufficiency. Thyroid extract was prescribed, and when I saw the patient three months afterwards the change for the better was remarkable. She was bright and alert, had lost the puffy appearance, and felt perfectly well, although her appetite was not keen.

The literature on this subject has been admirably summarized by E. Waller, of Stockholm, in the *Annals of Surgery* of October, 1917. As his paper is so recent it is unnecessary to deal exhaustively with reports of cases in this communication. It is of interest, however, to note that the first case resembling the one described was a patient in the Whitworth Hospital in 1817. It is reported in the *Dublin Hospital Reports* of that year by Dr. Todd. The salient features of the thirty-six cases (including my own) reported may be presented as follows:—

Age.—The average age was 13, the youngest patient being 2 years old, the oldest 25. But Heiliger, according to Waller, reported the condition in a mature male fœtus in 1910.

Sex.—Five of the patients were males and the rest females.

Pathology.—The pathological condition found is a large cyst of the upper and middle

portions of the common bile-duct; the lower part is not affected, nor are the hepatic ducts dilated. Some of the cases described are to be considered as those of excessive dilatation of the bile-passages rather than true cysts of the common duct. The usual size of the cyst when discovered is that of a man's head. A capacity of four to five litres has been recorded. There is considerable uniformity in the anatomical displacements produced by the slowly distending duct. The duodenum is pushed forwards and medially. In two cases, including the one presented, its second stage was flattened out against the anterior abdominal wall. The transverse colon is displaced downwards and towards the left. In advanced cases the gross appearance of the liver suggests biliary cirrhosis.

Etiology.—The fact that a cyst of the common bile-duct, 3 cm. wide and 2½ cm. long, was found in a mature male fœtus, suggests that the condition is probably congenital. In this fœtus, bile was present in the intestine and there was no icteric discoloration of the tissues. It seems likely that the congenital condition may exist for a variable time before giving rise to symptoms. Whether the onset of symptoms is the inevitable consequence of the congenital abnormality, or whether it depends on some exciting cause such as gall-stones or local inflammation, is at present undecided.

Symptoms.—In only one case was jaundice absent. In two there was slight tingeing of the sclerotic and a small amount of bile in the urine; but in the remainder jaundice of marked degree was a striking symptom. It is usually intermittent, without complete remissions.

The presence of an abdominal tumour was the prominent physical sign in every case. The tumour was situated in the right hypochondrium, and extended into adjacent regions according to its size. It was sometimes cystic, but often hard; when the former it simulated a pancreatic cyst, a dilated gall-bladder, or a hydronephrotic kidney; when the latter, growths of the colon, pancreas, or liver. In most cases the tumour had a very slight degree of mobility. In a few cases which were under observation for a lengthy period, the size and consistency of the tumour were observed to increase some hours after the ingestion of food.

Attacks of colicky pain are usually present, and sometimes exceedingly severe. They may precede the onset of abdominal swelling by some months, as in my case, and are sometimes associated with fever.

Ascites has resulted from pressure on the portal vein in three cases. Intestinal obstruction was a complication in one.

Diagnosis.—The diagnosis in an established case should present few difficulties if the possibility of such a condition is realized. The combination of jaundice, pain, and large tumour in a young individual should indicate the diagnosis.

Attacks of severe pain in the gall-bladder region, with deepening of the jaundice at the end of the paroxysms, may suggest the presence of stone in the common duct, but the presence of a large tumour is not in accordance with the usual symptoms of that condition, nor are gall-stones common in youthful patients. In several cases reported, however, jaundice and pain preceded the appearance of the tumour by a long period, in one case by two and a half years. In such cases the symptoms may resemble those of biliary cirrhosis, especially when the paroxysms of pain are accompanied by fever. The similarity may be accentuated on percussion by finding an increase of liver dullness due to the intimate relation of the liver to the cyst, which is not of itself palpable. There is, however, no enlargement of the spleen, and the pain is of a more acute nature in cysts of the common duct. In one case jaundice was absent; in this, the paroxysms of pain and the tumour were the only symptoms. When jaundice is present, the involvement of the liver or biliary passages is indicated; but when pain is the only symptom or tumour the only sign, or when pain and tumour are associated, the relation of the liver and its ducts to the condition is not so clear.

It is in cases of the latter type that I strongly advocate the employment of Ehrlich's test for urobilinogen in the urine, though it should prove of value even when the three cardinal symptoms are present. In every case in which this reaction was positive we have

found definite organic disease in the liver. The reaction depends on the following physiological facts: Hæmoglobin is broken up in the liver into hæmatin and globin; hæmatin undergoes dissociation into iron and bilirubin; the latter is excreted in the bile. When bilirubin reaches the intestine it is reduced by bacteria to urobilinogen, some of which is excreted in the fæces, and some is absorbed by the portal circulation and returns to the liver, where it is converted into bilirubin, thus completing a circulation of this substance. If hepatic activities are modified by disease, the liver fails to transform urobilinogen into bilirubin, and the former is absorbed into the general circulation, to be excreted in the urine.

The test has all the advantages of simplicity. A few drops of Ehrlich's reagent are added to a quarter of a test tube of the patient's urine. In a few seconds a rose-pink colour develops when the reaction is positive. All Dr. Nesbitt's experiments were carefully controlled, and the conclusions which I have given above were reached.

Any urine gives the reaction on boiling. The urine must be fresh; otherwise urobilinogen becomes oxidized to urobilin, the recognition of which is a much more complicated and uncertain matter. This test is, of course, of use in many other conditions than the one under discussion, but its utility is probably greater when a cyst of the common bile-duct is suspected, since in this affection there are so few collateral symptoms. When such a biliary cyst resembles a hydronephrotic kidney on physical examination, the correct diagnosis might be established by a positive reaction to Ehrlich's reagent; but a pyelograph of the right kidney would exclude that organ with greater certainty.

Treatment.—That the successful treatment of the condition is a matter of great difficulty can be seen by the results of operations.

RESULTS OF TREATMENT IN THIRTY-SIX CASES.

1ST OPERATION	2ND OPERATION	NO. OF CASES	DIED	RECOVERIES AND REMARKS
Drainage	—	18	18	1 recovered from operation, lived 3 years with fistula, died of phthisis
Drainage and choledoch-enterostomy	—	1	1	0
Drainage	Drainage	1	0	Living 3 years 8 months; fistula closed 2 years 8 months
Drainage	Attempt at choledoch-enterostomy ..	3	3	0
Drainage	Choledochenterostomy	3	0	3
Extirpation	—	3	3	0
Choledochenterostomy ..	—	2	0	2
Unoperated	—	4	—	—
Fœtus	—	1	—	—
	Totals	36	25	6

The fact that each surgeon encountered a condition previously unknown to him must account in some degree for the high mortality; but the prime factor in this mortality was the neglect of the surgical principle that a sterile cavity should not be drained. Infection is practically unavoidable if drainage is established. That aseptic drainage *can* be carried out is beyond dispute, but the probability of infection is in direct proportion to the duration of the external fistula.

Of the 19 cases treated by drainage alone, 18 died, and the single case which survived

had to be operated on a second time for infection of the cyst. This acute inflammation appeared to be curative in the case reported, for there was no subsequent dilatation; but such a result must be regarded as due to an 'act of God' rather than to surgical skill or judgement.

The results of extirpation were uniformly bad, and were in large part due to the fact that the surgeon did not know what he was extirpating. Given such knowledge it might be possible to perform extirpation in spite of its difficulties, and re-form the duct after its ancient image; but if any simpler procedure is feasible it should be adopted.

Of the 6 cases which recovered, an anastomosis between the cyst and the intestine was performed in 5. The difficulties of this operation as a secondary procedure are considerable, as can be judged by the fact that three surgeons have attempted it and failed, their failure leading to a fatal result. Such a primary operation could have been performed in my case between the first stage of the duodenum and the cyst.

The steps of the operation which I suggest are as follows: (1) Make or confirm the diagnosis on opening the abdomen; (2) Further confirm the diagnosis by aspirating the cyst retroperitoneally, as is usually possible; (3) When the cyst wall has collapsed, perform an anastomosis between it and the duodenum as in a cholecystenterostomy.

I have retained the descriptive term 'cyst of the common bile-duct' in order to bring this case into line with similar cases reported. The condition is, however, not a cyst but a diverticulum of the duct, and it would be better to designate it in future under this appellation.

HÆMORRHAGE AND POST-OPERATIVE OBSTRUCTION IN SUPRAPUBIC PROSTATECTOMY: AND AN OPEN OPERATION FOR THEIR PREVENTION.

By J. W. THOMSON WALKER, London.

The operation of suprapubic prostatectomy described by Freyer in 1901 has stood the test of time, and is now universally practised. No certificate is required to prove its success either in regard to the low mortality in experienced hands, or in regard to functional results. It is of interest to note, however, that at St. Peter's Hospital 1276 cases of enlarged prostate have been operated on by this method since the first operation in 1901 up to the end of 1918. Of these, 104 died; a mortality of 8·13 per cent.

It is not my object in the following notes to decry a procedure so patently successful. My idea is that improvement may be made even in this successful operation, provided that the object of the variation is to meet some disadvantage, or untoward event, which is of more than accidental occurrence.

There are two occasional incidents in the operation of suprapubic prostatectomy that call for prevention rather than cure, and it is in order to meet these that the technique here described has been developed during the past four years. These incidents are: (I) *Hæmorrhage*; and (II) *Post-operative obstruction*; and I shall discuss each before turning to the preventive treatment.

I. HÆMORRHAGE.

First, let us consider the question of hæmorrhage. I think that anyone who performs many prostatectomies must meet with cases of hæmorrhage severe enough to cause grave anxiety, and on very rare occasions to lead even to a fatal result. My experience in this respect does not, I believe, differ from that of others dealing with considerable numbers of such cases.

The frequency with which serious hæmorrhage occurs is difficult to state, for what may be counted a serious hæmorrhage in one patient may, from a more robust habit, or a greater resiliency, be looked upon as trivial in another; and, moreover, it is easy to forget a successfully treated hæmorrhage in the rush of clinical work. A long period of immunity from such cases may give a false sense of security, which is suddenly dispelled by a series of anxious cases.

I estimate that 10 per cent of cases of suprapubic prostatectomy bleed severely, and that about 1 per cent have really serious hæmorrhage. The direct mortality of hæmorrhage is very small. I find only two cases in the statistics of St. Peter's stated as due to hæmorrhage. At the same time it must be remembered that loss of blood, while it is seldom the direct cause of death, is none the less a contributory, if not the deciding, factor in the cases that are certified as death from 'shock' (10 cases), 'cardiac failure' (9 cases), 'syncope' (3 cases), 'exhaustion' (7 cases); and its weakening effect must have at least some influence on the result in cases dying of 'asthenia,' or of pulmonary or bowel complications. In a long experience of suprapubic prostatectomy I have only had one death that I ascribed as immediately due to hæmorrhage.

Hæmorrhage occurs at the time of the operation or at a later date. At the operation it may be troublesome from the start of the enucleation, and continue after enucleation is complete. On the whole, however, the cases that bleed early in the enucleation usually settle down very satisfactorily when the prostate has been removed. The worst cases

of hæmorrhage at the time of the operation that I have met with were those where the enucleation proceeded with practically no hæmorrhage. Then, when the operation was nearly over, hæmorrhage commenced, and was severe and difficult to control. In these cases there was undoubtedly a considerable degree of shock with its attendant low blood-pressure during the enucleation, and a sharp reaction when the enucleation was completed.

It is not easy to say, before operation, which cases will bleed and which will not. A high blood-pressure naturally suggests the risk of hæmorrhage, and on the whole these cases bleed more frequently and more severely than those with a quiet soft pulse. A large succulent prostate is more likely to bleed than a smaller one. This is not, however, invariably the case. The largest prostate that I have removed, and so far as I know, the largest that has ever been removed, weighed 24 oz. (1½ lb.), and although the bleeding was free during enucleation, owing to my knife plunging into the great prostatic mass in opening the bladder, it settled down rapidly after enucleation, and gave rise to no trouble after the operation.

The following is a short note of this remarkable case :—

Case 1.—R. L., age 76, a patient of Dr. Pringle Morgan, of Seaford, had suffered from prostatic symptoms for twenty-five years, and had been completely dependent on the catheter for twenty years. No catheter less than 16 inches in length would draw the urine, and this only when pushed in until it almost disappeared in the urethra. For some years there had been difficulty in introducing the catheter, and on one occasion catheterization was impossible. He had lost flesh, and was subject to attacks of bronchitis, but his general condition was fairly good. The prostate felt from the rectum was very large and elastic, and filled the whole pelvis. I tied in a 16-inch catheter for a few days, but he became restless and uncontrollable at night.

On Dec. 6, 1918, the temperature was 101°, and I decided to drain the bladder suprapubically, and leave the enucleation to a later date. The bladder was distended with fluid and exposed. On incising the bladder wall, the knife plunged into the prostate, which rose well above the pubic symphysis. Bleeding was profuse and persistent, and I decided to remove the prostate at once. Owing to the size of the glaud, there was only just room to slip the fingers between the prostate and the brim of the pelvis, the bladder wall intervening. The gland shelled out readily, but it was necessary to split it in two in order to remove it from the bladder. Hæmorrhage was very moderate during and after the enucleation. The cavity from which the prostate was removed was equal in extent to the cavity of the bladder. The bladder was drained with a large tube. The prostatic mass consisted of two large lobes with a fairly smooth outer surface. There was no indication of a medium lobe.

The following is a report by Dr. G. L. Eastes : "This enormous prostate weighed 1½ lb., or 680 grms. Two large sections have been cut, and they showed marked hypertrophy and hyperplasia of the gland alveoli. The structure is that of a simple adenomatous hypertrophy, and is innocent."

The patient bore the operation well, and the bleeding after the operation was very slight. Bronchitis gave rise to a good deal of trouble, but the convalescence was otherwise uneventful.

A prostate subject to years of catheterization with an infected bladder, and a prostate where the bladder has previously been drained suprapubically, bleed, I believe, less severely after prostatectomy than a virgin prostate.

Reactionary hæmorrhage a few hours after the operation is probably the most common form of hæmorrhage. The patient is recovering consciousness after the anæsthetic ; he may be, and often is, restless ; clots form in the bladder, causing severe spasmodic pain and straining, and are forced out of the large tube, and fluid blood or clots are projected along the urethra.

Serious hæmorrhage at the end of a week or ten days may be due to sepsis, but it often results from over-exertion or straining on the part of the patient, from the rough passage of the catheter along the urethra, or from the use of large enemata. The latter is, in my experience, one of the most frequent causes.

These hæmorrhages are all arterial, but a less acute although very persistent venous bleeding with less clotting may occur, and is sometimes difficult to control.

Prevention and Treatment.—The measures for preventing and treating hæmorrhage in Freyer's technique consist in massaging the walls of the prostatic cavity with the finger after enucleation, and then irrigating the prostatic cavity and bladder with large quantities of hot weak silver nitrate solution ; and to this may be added elevation of the foot of the bed on blocks.

For all late hæmorrhages, that is, hæmorrhages occurring after the patient has been returned to bed, my practice has been to instal constant irrigation with weak silver nitrate solution, and continue this for several days. A catheter is tied in the urethra with the eye just inside the prostatic cavity. This is connected with a jacketed reservoir, a glass dropper being interposed, and the rubber supply-tube being conducted over a hot-water bottle to keep up the temperature of the fluid. The outflow from the bladder wound is collected by a Hamilton Irving suprapubic apparatus, and carried to a pail at the side of the bed. The flow is kept at a rapid drop. Should this fail, packing of the prostatic cavity is the next resort. An anæsthetic is usually necessary for this. A silk-wove catheter is passed along the urethra and pushed well into the bladder, and round this the prostatic cavity is packed. The right forefinger is introduced into the bladder through the suprapubic wound till the tip lies at the inlet of the prostatic cavity. Along this finger a long strip of two-inch iodoform gauze is passed by means of a curved instrument such as a uterine sound or a curved periosteum elevator. The gauze is packed into the prostatic cavity round the catheter, and pushed firmly in with the forefinger till the cavity is tightly filled. The large suprapubic tube is replaced, the foot of the bed raised, and a hypodermic injection of a quarter grain of morphia is given. The packing remains in place for from forty-eight to seventy-two hours. Before withdrawing it, the catheter should be drawn out until the eye lies in the packed prostatic cavity, and then a continuous stream of silver nitrate solution (1–15,000) started. This loosens the packing, and allows the withdrawal to be accomplished more easily. The iodoform gauze keeps quite sweet; in fact there is less tendency to infection and more rapid healing in these cases than in those where such treatment has not been necessary.

Hagner[1] has introduced an indiarubber bag attached to the end of a rubber tube. The tube passes along the urethra, and the bag lies in the prostatic cavity. To produce pressure the bag is inflated through the tube and presses on the walls of the prostatic cavity. There is a tendency for the bag to float out of the prostatic cavity unless held firmly in position by some means such as continuous tension on the tube, but this gives rise to severe discomfort.

Soresi[2] uses a similar bag with an additional tube which is brought out of the suprapubic opening. This he fills with mercury, which by its weight presses the bag more closely on the walls of the prostatic cavity and keeps it in position. Keyes[3] passes a long Reverdin needle through the perineum into the prostatic cavity, through the torn edge at the bladder-neck on each side, and back again through the perineum. The ends of the suture are tied round a rubber tube on the perineum.

II. POST-OPERATIVE OBSTRUCTION.

The operation of prostatectomy is performed for the relief of one or more of three conditions, viz., complete or partial retention of urine, prostatic irritation, hæmorrhage. It is a serious reproach to the surgeon if relief from these very obvious conditions is not obtained. I shall only discuss the first of these, namely, retention of urine.

Where the operation of prostatectomy has been performed, and the patient still has residual urine or complete retention, either: (1) The case operated upon has not been suitable for prostatectomy; or (2) The operation has been imperfect.

1. **Cases which were Unsuitable for Prostatectomy.**—This group comprises cases where there is atony of the bladder. There are two types of cases with atony of the bladder: (*a*) Cases where symptoms of organic disease of the spinal cord are present; (*b*) Cases where symptoms of nervous disease are absent.

a. Atony of the Bladder with Nervous Disease.—The most obvious cases of bladder atony are those of organic disease of the spinal cord, of which tabes is the most frequent. There is not space here to deal fully with the question of prostatectomy in patients suffering from tabes, but passing notice must be taken of this subject. The mistake of attempting prostatectomy in a purely tabetic bladder, with the idea that the residual urine is due to prostatic obstruction, should never be made if the patient is fully

examined before the operation. There are cases, however, where the symptoms of tabes are so slight and irregular that they may easily be overlooked. The absence of enlargement of the prostate felt by the rectum, the younger age of the patient, the absence of intravesical enlargement of the prostate on cystoscopy, and the typical atrophic trabeculation of the bladder wall, should lead to a careful investigation of the nervous system and prevent such a mistake.

At the same time the presence of tabes does not prevent the development of prostatic enlargement, and where the conditions are coincident, it is a very difficult problem to solve whether a residual urine, measuring, say, 8 or 10 ounces, is due to the atony of nervous disease or to obstruction.

Several factors will influence the decision. There is the time at which the bladder symptoms first appeared: if within the prostatic age (over 50), or prior to this. There is the absence or the prominence of bladder irritation, excessive irritation influencing the surgeon towards a diagnosis of prostatic cause, and complete absence of irritation indicating that the condition has a nervous origin. Neither is however conclusive, for the bladder in multiple sclerosis is often of a spasmodic type, and cystitis in a tabetic bladder may produce frequent micturition or strangury; while the bladder subject to chronic prostatic obstruction may give rise to no discomfort or irritation. Finally, the type of the trabeculation, as seen by the cystoscope, may help: a fine atrophic type with widespread sacculation being specially associated with tabetic atony, and a thick fleshy type with obstructive retention.

Prostatectomy is not contra-indicated by the presence of tabes if the prostate is definitely enlarged, but the grave risk of leaving an atonic bladder after the operation must be carefully weighed. I have performed prostatectomy three times on patients the subject of advanced disease of the spinal cord—twice in tabes and once in multiple sclerosis—and in all with success, the vesical function being completely restored to its normal condition.

b. Atony of the Bladder without Nervous Disease.—Some years ago I described[4] a group of cases, occurring most frequently in young men, where there was atony of the bladder without obstruction, and without symptoms of nervous disease. The group has not been widely recognized. The diagnosis is difficult. Early irregular tabes must be carefully excluded by lumbar puncture and other means, and contracture of the neck of the bladder and atrophy of the prostate must be searched for and excluded by thorough investigation. These cases are frequently diagnosed as stricture, and prolonged treatment for stricture in different hands of varied skill leads with certainty to injury to the urethra and sepsis, so that the cases ultimately become so complicated as to be hardly recognizable if the primary condition is not clearly impressed on the surgeon's mind by the study of virgin cases.

The recognition that such cases do exist appears to be dawning upon the profession, for here and there in the literature a reference to one may be found. Burns,[5] in a recent article from the Brady Institute, Johns Hopkins University, states, "There is a class of cases in which the cystoscopic and röntgenographic pictures are absolutely typieal of disease of the central nervous system, but in which no evidence of such disease can be demonstrated clinically or serologically," without, however, referring to, or possibly being aware of, my original description. The differentiation of these cases is of extreme importance if an occasional disaster in the after-results of prostatectomy is to be avoided. They should be present in the mind of the surgeon whenever the symptoms of difficulty and chronic retention of urine are greatly in excess of the ascertainable urethral or prostatic obstruction, and where symptoms of nervous disease are absent.

2. **Cases where the Operation has been Imperfect.**—I pass now to post-operative obstruction following prostatectomy, the subject to which the above remarks are an introduction.

It is many years since I pointed out[6] that there were two danger-points for the development of stricture after prostatectomy, namely, at the membranous urethra where the mucous membrane is severed, and at the outlet of the bladder when the mucosa of the

bladder neck is torn across. It is very rare to find any tendency to contraction at the membranous urethra, partly, I believe, because it is the custom to pass the catheter in order to wash the bladder during convalescence.

At the entrance from the prostatic cavity into the bladder the danger of contraction is greater. In order to understand this, a glance at the anatomy of the vesicoprostatic opening is necessary.

The hypertrophied prostate enlarges in two directions, namely, into the bladder through the lumen of the vesical sphincter, and backwards outside the bladder, stripping the seminal vesicles and the fascia covering them from the bladder base.[7] After enucleation of the prostate, the seminal vesicles, covered by fascia, form part of the posterior wall of the prostatic cavity, and the bladder base forms a canopy over the posterior part of the cavity, with an opening into the bladder situated well forward at the anterior limit of the cavity. The opening may not be very large at the time of the enucleation, and during the first fortnight the edges may gradually coalesce so that a complete canopy forms over the prostatic cavity, shutting it off from the bladder. Occasionally the lateral folds unite and produce the same result (*Figs.* 432*a* and *b*).

It is easy to deceive oneself in passing a catheter in such a case, and to believe that the point of the instrument is in the bladder, while all the time it lies in the prostatic cavity, and is pushing up the canopy like a tent-pole. The visible effect of this on the convalescence is that the suprapubic wound does not heal, and a fistula forms. This is not the only cause of fistula after suprapubic prostatectomy, but it is one of them.

The fact that obstruction is taking place at the bladder outlet should be recognized at the time when the wound is nearly healed and a catheter is being passed. The want of freedom of the catheter point, the increasing difficulty in washing through the catheter and out of the wound, and the delay in healing of the wound, all point in this direction.

The obstruction may not be complete. It may be sufficient to prevent the catheter passing into the bladder, and to keep the suprapubic fistula open, but may still allow a little urine to pass into the urethra occasionally; or, again, the urine passed may gradually diminish and ultimately cease.

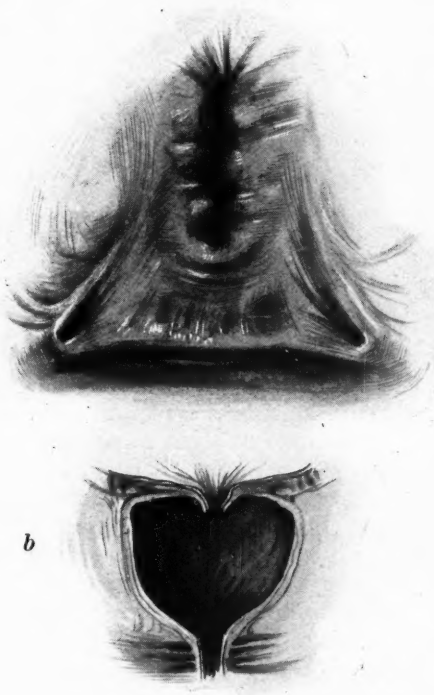

FIG. 432.—Opening from bladder into prostatic cavity after prostatectomy; lateral folds of mucous membrane almost in apposition. (*a*) View from bladder: (*b*) Coronal section.

If the condition is recognized in an early stage, it is easy to slip the finger along the partly healed wound and meet the tip of a catheter which is forced through the spot where the opening should be, now detected as a dimple or a bud of soft granulation tissue. A series of metal bougies of increasing size is passed, and then a large gum-elastic bougie tied in for a week or ten days. If, however, there is delay in recognizing the cause of the persistent fistula, a complete opening up of the bladder is necessary to correct the condition.

There is another condition causing post-operative obstruction which is more difficult to diagnose. A loose nodule (*Fig.* 433) or a flap of tissue (*Fig.* 434) plugs the entrance of the prostatic cavity, and causes intermittent obstruction. This may develop soon after the patient commences to pass water by the urethra. There is sudden obstruction, with pain and straining, and after a day or two a large slough, sometimes impregnated

with phosphates, is passed, and micturition becomes free. In such a case it has probably been found that, with all possible care to prevent it, the bladder became infected, or, where infection previously existed, no amount of washing sufficed to clear it up. Then the loose flaps or masses of tissue have sloughed, but have eventually been passed, and the condition has been spontaneously cured.

In other cases the wound heals quickly after the operation, and the patient passes water well for a time. After a few weeks, intermittent difficulty begins to appear. In some cases a symptom which I believe is typical of the condition develops. The act of micturition commences well, but, as it proceeds, difficulty develops and increases, and the stream falls away to a dribble, and may cease. The more the patient strains, the

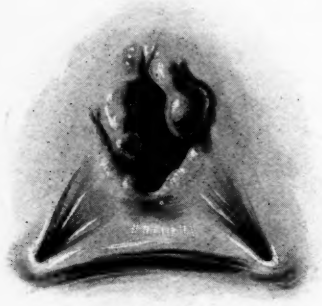

FIG. 433.—Nodules of prostatic tissue at the prostatovesical opening.

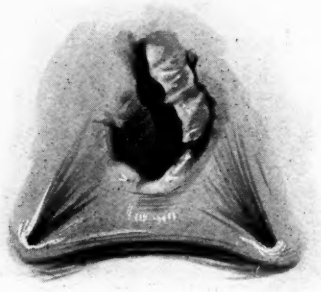

FIG. 434.—Strips of mucous membrane at the prostatovesical opening.

greater becomes the difficulty in discharging the urine. He soon learns that the best stream is obtained by avoiding all effort, and if possible checking any great rush of urine and reducing it to a moderate flow.

Sometimes an even more significant symptom develops. The patient can pass water freely while lying on his back, but with great difficulty, or not at all, standing up. The wound may break down and a urinary fistula form, alternately healing and breaking down; but the scar may be proof against the intermittent obstruction, and remain firm. The passage of large metal instruments may improve micturition for a time, but it does not cure the valve action.

The following are two cases selected from a number that have come under my observation.

Case 2.—Rev. P. E. W., age 64, suffered from nocturnal frequency of micturition. The prostate was enlarged, and there were six ounces of residual urine. In November, 1917, the prostate was enucleated by a urinary surgeon. Urine commenced to pass by the urethra in three weeks. Catheters were passed, but there was difficulty in getting them into the bladder. The catheter was arrested at the entrance to the bladder, and the difficulty increased until the passage became impossible. The suprapubic wound remained open, and the urine passed partly by the urethra and partly by the fistula.

In February, 1918, the surgeon again operated. The bladder wound was opened up, and a catheter passed and tied in the urethra. The wound healed, but broke down again, and there were recurring periods of leaking from the suprapubic fistula. Micturition was performed with straining, and a catheter was passed with difficulty, the obstruction being at the neck of the bladder, as before. Sometimes the obstruction caused complete retention. The difficulty in passing urine was greater the more the bladder was distended. At night he could not pass water without introducing the catheter.

On April 29, 1918, I operated, removing the suprapubic scar and opening the bladder freely. The vesicoprostatic opening was a small aperture which gripped tightly a small curved catheter. It was surrounded by a thick cuff of hard fibrous tissue more prominent on the right side. The subjoining prostatic cavity was covered by a canopy of mucous membrane and fibrous tissue, and the urethral opening lay at its anterior margin. I cut away the whole of this, exposing the prostatic cavity, which was funnel-shaped. The bladder was drained. On May 10 the wound was nearly healed, and urine was passed partly by the wound and partly by the urethra.

A catheter passed easily and without meeting any obstruction. In July, 1918, his doctor reported that he was perfectly well. The wound was firmly closed and micturition was normal. He has occasionally passed a little blood in the urine.

Case 3.—Canon H., age 71, had suffered for some years from increasing frequency of micturition, and finally he had an attack of retention of urine, for which a catheter was tied in the urethra. The patient suffered from emphysema, bronchitis, and a dilated heart, and had glycosuria. On Jan. 14, 1918, his surgeon performed suprapubic prostatectomy. The prostate was large, and shelled out in one piece. There was difficulty in separation on the left side and posteriorly.

The after-treatment was conducted by the general practitioner. Progress was uneventful until, three weeks after the operation, the doctor attempted to pass a catheter and failed, and the surgeon was also unsuccessful. On Feb. 17 the suprapubic wound had nearly healed. The urine was ejected from the remaining fistula every two or three hours, but none passed by the urethra. Under an anæsthetic the surgeon introduced a finger into the bladder and passed a No. 10 urethral bougie through the urethra, and tied in a catheter. The catheter was retained in the urethra for fourteen days, when it slipped out and could not be replaced. On March 21 I examined him. The urine was discharged entirely by the suprapubic fistula, none passing by the urethra. A metal instrument was arrested at the entrance into the bladder. I opened the bladder freely, and found that the prostatic cavity was completely closed over by a thick membrane; no opening from the bladder into the urethra could be found. A metal bougie, passed along the urethra, raised up this canopy, and it was caught in a pair of vulsellum forceps and a piece cut out. The opening was then extended by cutting away the remains of the canopy, and a large opening leading from the bladder into the funnel-shaped prostatic cavity was obtained. A month later the suprapubic wound was healed and the urine passed naturally. About three months after the operation he died of cardiac failure, having continued to void his urine naturally till the end of his life.

THE METHOD OF PREVENTION.

Prevention lies in performing an open operation in which the bladder and prostatic cavity are fully exposed, the hæmorrhage is treated, and all nodules and strips of tissue and valves are removed.

Let me describe the operation in detail. A catheter is passed, and the bladder distended with 12 or 14 ounces of fluid. A free suprapubic incision is made, the bladder is opened, and the prostate enucleated with the gloved right forefinger, the gloved left forefinger in the rectum pushing up the prostate to aid the enucleation. The prostate being free in the bladder, the left forefinger is removed from the rectum, the glove is stripped from the left hand by a nurse, and the sleeve of the gown drawn up over the left elbow. The left forefinger, after plunging the hand into biniodide solution, replaces the right finger in the bladder, and assists the removal, by ovum forceps, of the prostate from the bladder.

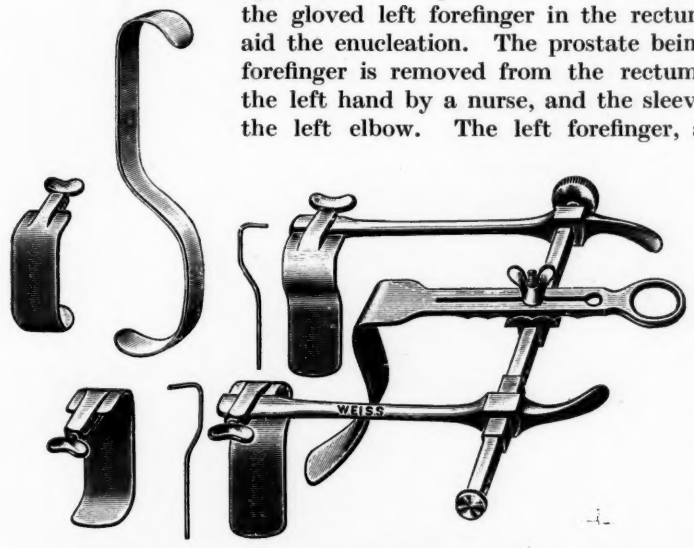

FIG. 435.—Author's bladder retractors. Abdominal frame with detachable bladder blades (shown also in profile) and spatula for posterior wall. Hand retractor for anterior wall. Detachable abdominal wall blades.

So far, except for the matter of gloves, the operation is that practised by Freyer. Now we depart from his technique. Instead of irrigating the bladder with hot solution, a catgut stitch is passed through each lip of the bladder wound, and the patient is placed in the full Trendelenburg position. A good head-lamp is essential for this part of the operation. I then introduce my bladder retractors (*Fig.* 435). A gauze swab is pushed into the prostatic cavity to control bleeding temporarily, and the bladder is emptied of clot. When this is done,

the plug is removed, and a careful inspection of the prostatic cavity and its inlet into the bladder is made (*Fig.* 436).

Hæmorrhage first claims attention. In some cases, by the position of the patient and the temporary plugging, the hæmorrhage has already been reduced to a very small amount of venous oozing, and it may be that no special measures are required to control bleeding.

In most cases, however, some amount of bleeding is in progress, and spouting arteries are seen in some. The bleeding is of two kinds, arterial and venous, and these can be clearly distinguished. Arterial bleeding comes almost invariably from an artery situated at the brim of the vesicoprostatic entrance slightly behind the mid-coronal line. There is usually a spouting vessel on each side in this position (*Fig.* 439). This artery surrounds the neck of the bladder, and can frequently be felt in a normal bladder beating against the finger at the internal meatus when the finger is introduced. It might be named the cervical artery of the bladder. It is found spouting at the brim of the prostatic cavity just below the mucous membrane. Long Spencer Wells forceps are placed on these vessels. With my handled bladder-needle, a catgut stitch is passed through the mucous

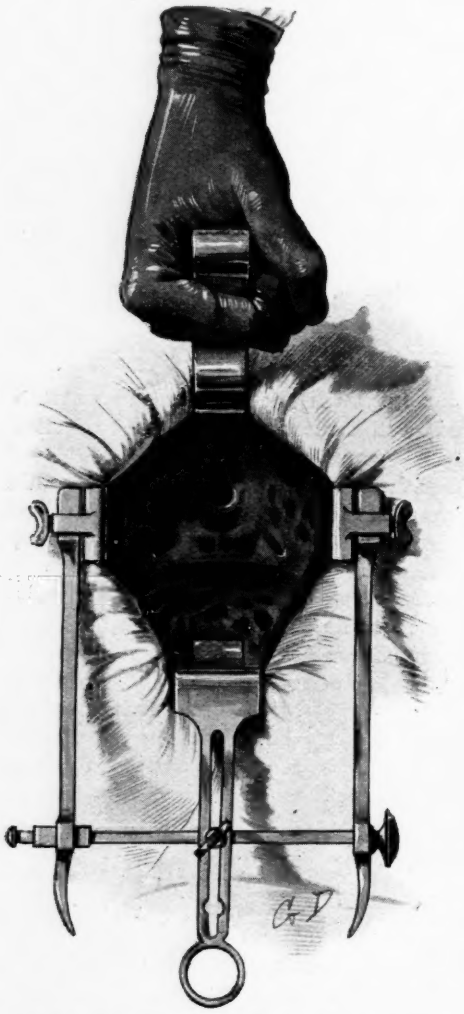

FIG. 436.—View of the bladder and vesicoprostatic opening, with retractors in place.

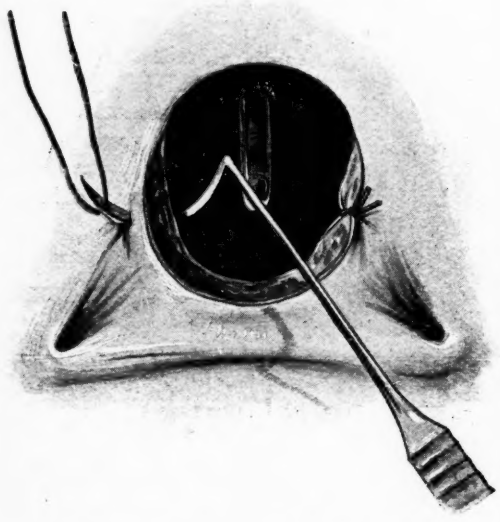

FIG. 437.—Introduction of hæmostatic stitches at brim of prostatic cavity.

membrane of the bladder and the sphincter, or what remains of it, appearing in the prostatic cavity below the brim. This is passed anterior to the forceps and tied, and the forceps removed. A second hæmostatic stitch is passed on the other side of the cavity (*Fig.* 437). These two sutures now act as tractors to pull up the neck of the prostatic cavity and keep the walls of the brim apart. Arterial bleeding from the wall of the cavity may be seen, but is not frequent. Venous hæmorrhage may be copious. Spencer Wells forceps are applied to any bleeding points, or, better, Moynihan's rather heavy artery forceps with

curved beak are applied, and the tissue in their grasp crushed. This bleeding comes, as would be expected, mostly from the anterior wall of the prostatic cavity.

It is well to remember that the venous system of the prostate commences in the dorsal veins of the penis, which pass under the pubic arch and, gaining size, up the anterior surface of the prostate in the middle line between the layers of the sheath. This vertical limb splits at the base of the prostate to form two arms of a Y which pass on in either side of the prostatic base at its junction with the bladder.

It is from the vertical limb of this Y that the venous bleeding comes, and if copious it is checked by plugging the prostatic cavity with gauze for a few minutes. It seldom gives rise to much trouble, and a certain amount of venous oozing may be neglected. In two cases when the venous bleeding from this source appeared threatening, I pushed the anterior wall of the bladder backwards, and stripped the anterior wall of the prostatic cavity from its light attachment to the back of the pubic symphysis, and then, with one of my long-handled bladder needles, passed a catgut stitch transversely through the wall of the prostatic cavity, and tied it so as to compress the vertical limb of the prostatic plexus. No ill effects, such as œdema of the penis, followed this manœuvre, and I should repeat it if serious venous hæmorrhage made it necessary. In practically all cases it is sufficient for the arterial bleeding to place a hæmostatic stitch in each side at the brim of the prostatic cavity and to plug the cavity temporarily. Sometimes these may be omitted and the crushing of the artery forceps relied upon to control the bleeding. In exceptional cases, I have had to plug the prostatic cavity with gauze (iodoform gauze in two-inch strips is the best for this purpose) when very severe hæmorrhage was in progress and it was impossible to see any single point of bleeding. This is very easily and accurately accomplished when the interior of the bladder is fully displayed with the retractor in place. The cavity is packed around the catheter, which is still in place and which projects well into the bladder cavity. The rest of the operation is finished as usual, and the plugging removed at the end of forty-eight or seventy-two hours.

Having controlled the hæmorrhage by suture as above, the next point to attend to is the removal of tags, flaps, strips, or nodules, in order to avoid post-operative obstruction or valve formation. A large variety of these occur. It is a revelation, when one comes to examine the prostatic cavity after enucleation of the prostate, to see the number, size, and variety of these loose masses of tissue. The following may be found :—

1. Strips and flaps of mucous membrane. At the vesicoprostatic opening there is frequently a large loose flap of mucous membrane on each side, and these flaps may almost meet over the prostatic cavity (*Fig.* 432). The flaps are loose and can be pushed aside. A long strip of mucous membrane sometimes lies loose at the anterior lip of the opening (*Fig.* 434).

2. Nodules of prostatic tissue in the neighbourhood of the opening (*Fig.* 433). These may be present even where the prostate has apparently shelled out cleanly.

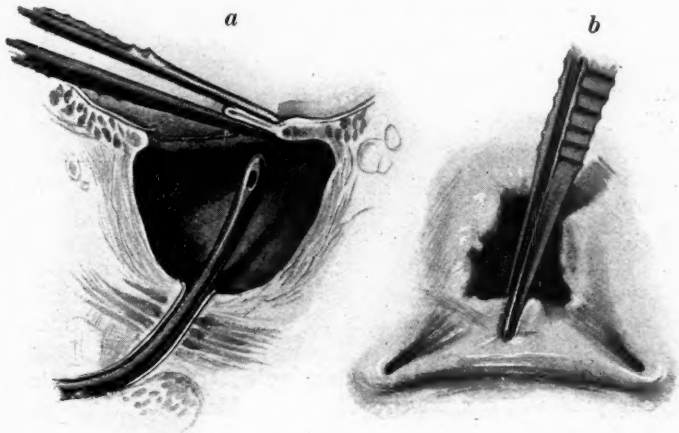

FIG. 438.—Canopy overhanging posterior part of prostatic cavity. (*a*) Sagittal section; (*b*) View from bladder aspect.

3. A prominent semilunar ledge forming the posterior lip of the opening. This tends to reduce the lumen, and occasionally causes complete occlusion of the orifice. This ledge is formed by the trigone and adjoining base of the bladder, and is produced by enucleation of the part of the hypertrophied prostate which extends backward beneath the bladder base (*Fig.* 438, *a*, *b*).

4. Loose strips of prostatic capsule, and occasionally small nodules of gland tissue, attached loosely to the wall of the prostatic cavity (*Fig.* 439).

5. Long loose strips of urethral wall pulled out and torn across.

All loose tags, shreds, and semi-detached nodules of prostatic tissue tend to slough, and are ready soil for the growth of bacteria. Where they do not slough they may form valves and obstructions, and cause intermittent or continuous obstruction. All these are carefully clipped away, and the mucous membrane is trimmed at the edge of the cavity.

A word must be said in regard to the fold lying at the posterior lip of the prostato-vesical opening. This is picked up on the middle line by forceps (*Fig.* 438), and a wedge with its base forwards cut out of it with long curved scissors (*Fig.* 440). The tissue removed

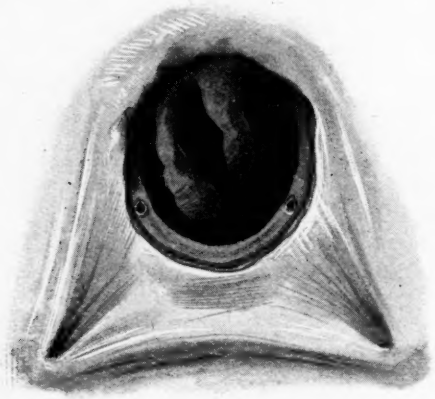

FIG. 439.—Loose strips of prostatic capsule hanging from wall of prostatic cavity. Note the two vessels on posterior ledge.

FIG. 440.—Prostatovesical opening with wedge cut in posterior fold.

consists of mucous membrane, trigonal muscle, and frequently some gland tissue. This effectually removes any possibility of narrowing of the vesicoprostatic opening.

In 1904 I pointed out[8] that the action of the internal vesical sphincter was destroyed in cases of suprapubic prostatectomy for enlarged prostate. This is partly effected by the prostate pushing its bulk through the sphincter into the bladder and expanding it, and partly also, no doubt, by the further stretching effected during the enucleation. The sphincter action is taken up by the compressor urethræ, which effectually prevents the escape of the urine. The prostatic cavity thus forms a prolonged neck communicating with the bladder cavity. After prostatectomy, a catheter passed along the urethra is frequently held up by this canopy, and the opening into the bladder may only be found by exploring forward with the point of the instrument. The posterior lip of the opening is formed by a hard fibrous sickle-shaped fold, while the anterior bladder wall passes into the prostatic cavity almost without a ledge to mark the junction. By cutting a wedge out of this sickle-shaped canopy at the time of the operation, subsequent occlusion of the orifice is prevented.

Having completed the clearing out of the prostatic cavity, and the enlarging of the vesicoprostatic opening, repair of the bladder and abdominal wall is undertaken.

I still consider that free drainage is essential to the success of the operation, and use the large (1 inch) rubber tube introduced by Freyer. The bladder retractors are removed and the blades changed for retraction of the abdominal wall. These blades are inserted in the pubic end of the wound with the framework now at the kneeward side of the operation field (*Fig.* 441). The bladder is pulled up by the catgut slings which are still in place, and the rubber tube carefully placed so as to reach, without pressing on, the base of the bladder. By traction on the slings, the wound in the bladder wall is freely exposed,

and is closed up to the tube by interrupted catgut sutures. Care is taken to avoid stitching the bladder wall too tightly round the tube, as this would cause post-operative spasm of the bladder. The slings are removed, and the bladder drops down into the pelvis. A small rubber tube is placed in the prevesical space, and the two tubes are clipped and held up while the abdominal wall is repaired. I place two catgut mattress sutures through the recti and sheath about an inch on each side of the wound, and unite the margins of the anterior rectus sheath with a continuous catgut suture. The mattress sutures are then tied and the skin united.

After-treatment.—When the patient has come round from the anæsthetic, a Hamilton Irving suprapubic box is applied, and he is propped up in bed.

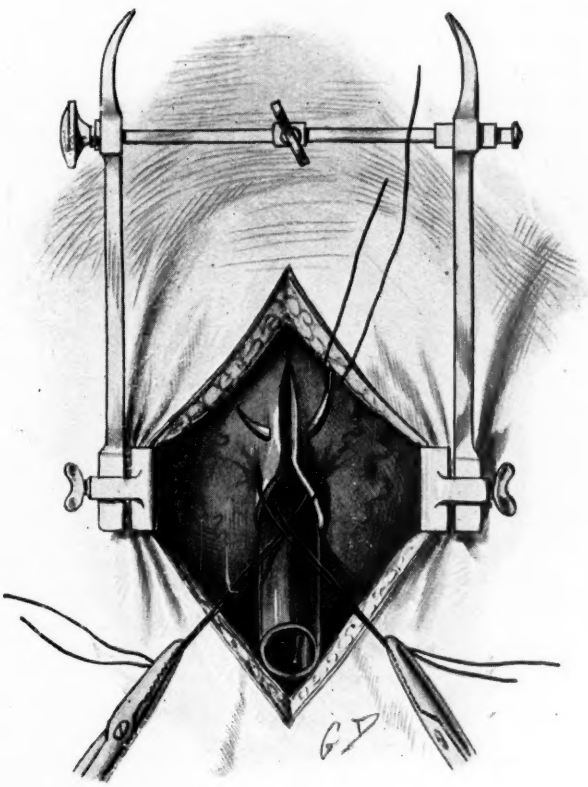

FIG. 441.—Retraction of abdominal wall; closure of bladder wound.

If there has been severe bleeding during the operation, and the prostatic cavity has been packed, the catheter will have been left in the urethra. If there is any suspicion that bleeding may recur, or if the bladder is the seat of chronic infection, the catheter is tied in without packing. Continuous irrigation (silver nitrate solution 1–15,000) through the catheter may be instituted, and is equally serviceable for commencing hæmorrhage or for chronic sepsis. It may be continued for four or five days, or even longer if necessary. Continuous irrigation is an excellent method of cleaning a septic bladder, and prevents further infection. The suprapubic wound heals quickly and cleanly under the treatment. It has the disadvantage of immobilizing the patient, and is very irksome to some individuals. The tubes are removed on the fifth completed day. Enemata should be avoided as far as possible.

COMMENTS.

1. Two objections may be raised to this operation. It requires a longer incision than the usual prostatectomy, and more time is required for its performance.

2. The longer incision suggests the possibility of a hernia of the scar; but hernia depends upon the ability of the surgeon to repair the abdominal wall and to keep the wound clean.

3. The incision should heal up to the tube channel by first intention, and the wound in my cases is firm and strong. With an efficient system of repair of the abdominal wall, a hernia need not be feared.

4. The length of time spent on the operation from start to finish is about thirty minutes, and I have seen no increase in the shock after the operation. Shock in prostatectomy is partly due to hæmorrhage and partly to rough handling in enucleation. Both of these causes can be avoided in this open operation.

5. An unexpected feature of the open method is the absence of a great part of the spasmodic pain after the operation. This pain, which lasts for twenty-four or forty-eight hours, is due partly to the large tube, but mostly to the accumulation of clots in the bladder, with consequent spasm of the bladder muscle in the attempt to expel them. The latter factor is abolished where the bleeding can be efficiently combated.

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THE THIGH-ROTATION OR OBTURATOR TEST: A NEW SIGN IN SOME INFLAMMATORY CONDITIONS.

By V. ZACHARY COPE, London.

The difficulty experienced in the diagnosis of some cases of appendicitis when the appendix is situated in the pelvis is sufficient excuse for recording any sign which may be of assistance. It is well known that rigidity of the abdominal wall may be absent even when there is an acutely inflamed appendix lying below the brim. If the inflamed mass be low down, a rectal examination will always detect it, but if it be lying against the upper part of the lateral wall, rectal examination, especially in a fat or sensitive subject, is often dubious or negative.

In these cases the anatomical relationship of the obturator internus muscle suggests a test which can easily be carried out; that is to say, by bringing the muscle into action, pain may be caused by the dragging on the contiguous inflamed tissues.

The test is elicited as follows. The right thigh is slightly flexed (so as to relax the psoas muscle) by the surgeon, who stands on the right of the patient; the limb is then fully rotated at the hip, first internally and then externally, so as to put the obturator internus through a full range of movement. The sign is positive if the patient complains of hypogastric pain when the limb is moved in this manner.

Since the fascia covering the obturator internus is fairly dense, the test is not positive unless the inflammation is considerable; and, with a positive result, one always expects the appendix to be adherent to, or even an abscess to be contiguous to, the fascia (*Fig.* 442).

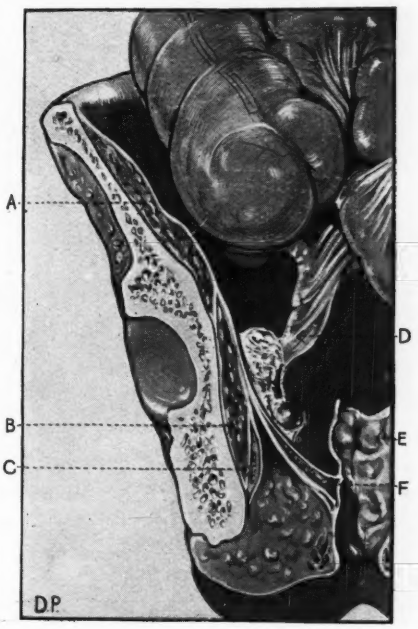

Fig. 442.—Diagram to show relationship of pelvic appendix to the obturator internus muscle. An appendicular abscess is seen in contact with the fascia over the obturator internus. A, Iliacus; B, Obturator internus; C, Alcock's canal; D, Appendix; E, Rectum; F, Levator ani.

I have found this sign of assistance not only in cases of appendicitis, but also in other pelvic conditions, such as ruptured ectopic gestation, and I have no doubt that it will often prove of value in doubtful cases. In a case of obturator hernia the test ought to be pathognomonic, but I have never had any opportunity of testing it in such a case.

SHORT NOTES OF RARE OR OBSCURE CASES.

AN UNUSUAL CASE OF KELOID.

By RUTHERFORD MORISON, Newcastle-upon-Tyne.

The two accompanying figures are those of a native who came to Dr. Burman for operation, because he could not get employment on account of the deformity of his ears. The ear tumours (*Fig.* 443) developed from openings made for earrings, and *Fig.* 444 shows the

Fig. 443.

Fig. 444.

result of the first operation for the removal of one of them. The body growths (*Fig.* 444) arose from scars left by scarification and burns produced by native doctors for the treatment of various ills. The clinical diagnosis made by Dr. Burman and confirmed by the pathologist was 'keloid,' and I think that will be generally acknowledged as a diagnosis with which many of us would be satisfied.

Keloids are interesting growths and require further research work to be expended upon them, because they form a link between the infections and malignant growths. They possess a local malignancy so pronounced as to make it almost certain that in this

case there will be recurrence of the growth which has been for the time so successfully removed. We also know that they are associated in some way with sepsis and tubercle of chronic type; that on the skin, burn scars, which take a long time to heal, and scars resulting from tubercle, are their favourite sites; and that they are more common in the black than in the white races.

It is not so generally recognized that similar growths are to be found elsewhere in the body, and it seems to me probable that all of them possess a similar etiology and pathology. The normal tendency of scar tissue to contract seems in them to be inverted, and the fibrous tissue of which they are composed, instead of contracting, takes on the habit of growth.

Such examples are to be found in the mouth and the gastro-intestinal tract. In the mouth they are known as gum tumours or epulis, one form of which is a fibrous tumour growing from an old septic tooth cavity and requiring a radical operation if its recurrence is to be prevented. In the stomach a similar development is known as linitis plastica, and the simple, not cancerous, type is associated with chronic gastric ulcer.

In the small intestine a similar growth has usually been preceded by strangulation of the portion of bowel invaded. The usual result of such a strangulation, which has not been sufficiently long-continued to cause gangrene, is fibrosis and contraction of the involved bowel. This is what could be anticipated from a knowledge of what occurs in the arm as a consequence of too tight a bandage taken off in time to avert gangrene. Arrest in the circulation of the arm is followed by fibrosis, and the condition is described as Volkmann's ischæmic contraction. But in a small percentage of cases strangulated bowel, instead of contracting, develops a fibrous growth of its walls and forms a tumour causing intestinal obstruction. Such a portion of bowel, when strangulated, is of course infected as a consequence of the damage produced.

In the cæcum a similar condition is described as hyperplastic tuberculosis, but I have excised several of these fibrous tumours in which no macroscopic or microscopic evidence of tubercle or cancer could be found in them or in glands related to them.

In the pelvic colon a fibrous tumour developed around infected sacculi has often been excised in the belief that a resulting intestinal obstruction was due to cancer, until macroscopic and microscopic examination of the specimen proved the contrary. The Americans call this peridiverticulitis.

It is well known, but perhaps not sufficiently considered, that cancer of the large intestine may develop either in the form of a contracting ring, or as a tumour largely composed of fibrous tissue; and what determines the one type or the other is unknown. To answer the question for keloids and the other fibrous growths mentioned is probably to answer it for cancer.

I am indebted to Dr. Charles Burman, of Ladysmith, S. Africa, my late house surgeon, for the photographs.

ABDOMINO-THORACIC GUNSHOT WOUND: DIAPHRAGMATIC HERNIA OF THE STOMACH.

By SEYMOUR BARLING, Birmingham.

The following case is of interest from the point of view of diagnosis, and is one of the many unusual conditions arising out of the aftermath of war.

The patient, age 28, was wounded on Aug. 12, 1918, by a machine-gun bullet, which struck him in the back over the lower part of the left thorax. He was operated on the same day, the wound being excised, fragments of rib removed, and the chest closed. The foreign body, a distorted bullet, was left *in situ*; the *x* rays showed that it was closely related to the heart, and moved synchronously with the heart-beat. He suffered from hæmaturia for a day or two after his wound. Following the wound he developed a left-sided empyema, which was at first aspirated and then drained. The wound continuing

to discharge, he was transferred to England and came to the Rubery Military Hospital in November, 1918.

About this time he began to get severe attacks of pain in the epigastrium and in the left shoulder; the pains at these two sites were synchronous, and were relieved to some extent by dieting.

He was seen by Sir Gilbert Barling, who considered that his pain was probably due to the foreign body, which lay $2\frac{3}{8}$ inches anterior to the angle of the 10th left rib, either just within or just without the pericardium, and in close relation with the left phrenic nerve. On Dec. 6, portions of the 9th and 10th ribs being removed posteriorly and the old empyema cavity opened up, access to the foreign body was obtained, and it was removed from the pericardium. The wound was drained freely. The patient improved considerably after this operation, and could take ordinary diet without discomfort until February, 1919, when he began to get attacks of his old pain in the epigastrium and left shoulder.

The attacks were now associated with vomiting, and on two or three occasions with

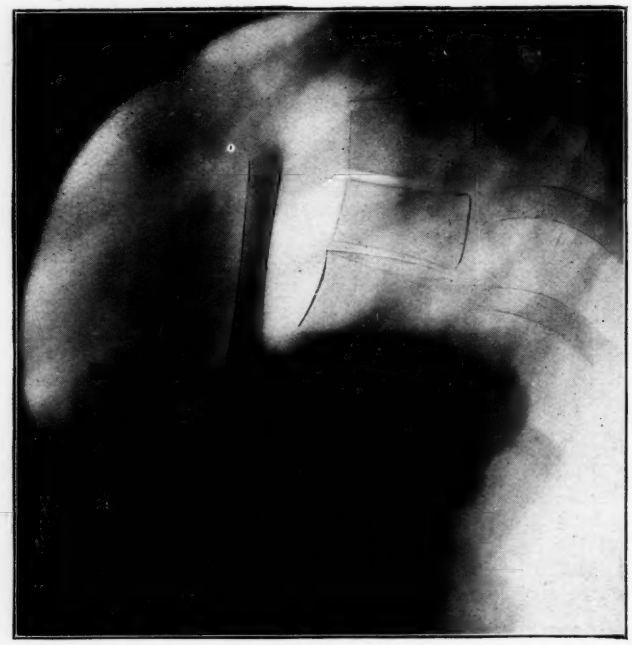

FIG. 445.—The bismuth meal at first passed easily into the stomach; then the latter part of the meal remained in the œsophagus and showed pulsation with respiratory movements. The picture is taken obliquely.

hæmatemesis, and persisted in spite of fluid diet. The radiographic findings after the administration of a bismuth meal were by no means clear, the presence of the heart and the thickened pleura at the left base obscuring the diaphragmatic shadow and its relations to the stomach. The following points were demonstrated, however:—

1. The lower border of the stomach was raised to the level of the 12th dorsal vertebra (*Fig.* 446).

2. The first portion of the meal passed easily through the cardiac orifice and demonstrated its patency; when the remainder of the meal was given, however, it remained in the œsophagus, and the column of fluid pulsated with the respiratory movements (*Fig.* 445). This appeared to point to some valve-like closure of the cardia when the stomach was filled beyond a certain amount, and probably resulted from the abnormal position of the stomach.

3. *Fig.* 446 is difficult to interpret: the curved shadow immediately above the opaque meal was believed by the radiographer to correspond to the paralysed left cupola of the diaphragm. It lies at the level of the 2nd costal cartilage, and it is more probable that it represents the thickened pleura on the under surface of the collapsed left lung, and that the diaphragm is at a much lower level, its movements and outline being masked by the adhesions in the pleural cavity. No paralysis could be demonstrated at operation, nor was the diaphragm as high as the shadow shown would indicate.

As the patient's nutrition had suffered severely, it was considered desirable to improve it before operation was carried out. He therefore returned to his home in the country, and by careful dieting managed to lessen the severity of his attacks.

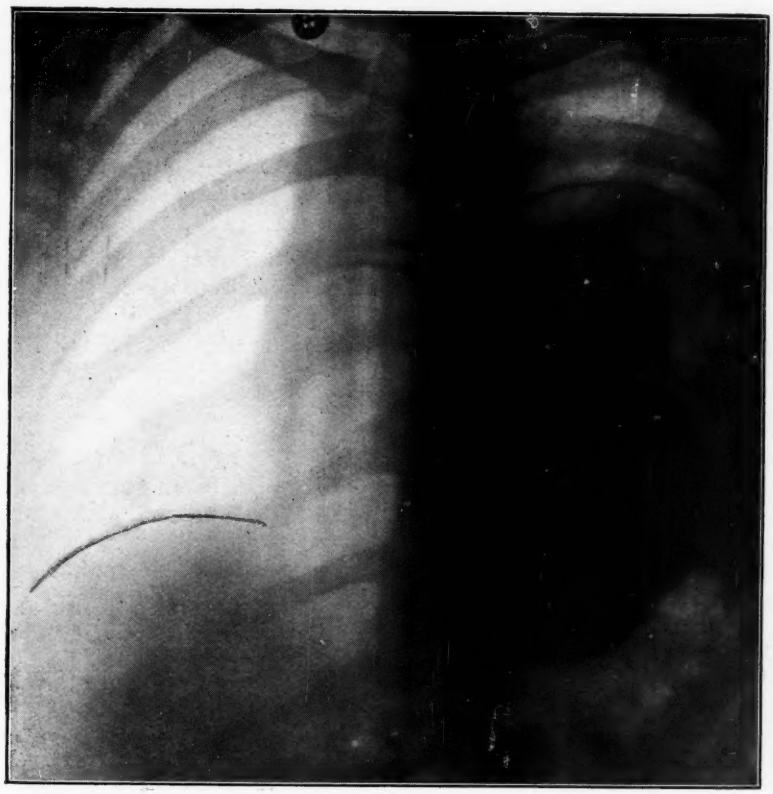

FIG. 446.—The level of the diaphragm on the right side is normal; on the left side a curved shadow at the level of the 2nd costal cartilage was taken for a raised paralysed diaphragm; it probably represents the thickened pleura on the under surface of the collapsed lung. The stomach is much raised, the lower border corresponding to the 12th dorsal vertebra.

He was referred to me in the latter part of July, 1919; he had put on weight since leaving hospital, but during the month he had had three attacks of his old pain, though he had dieted himself carefully. He relieved his pain whilst in hospital by putting his finger down his throat; this induced vomiting, which immediately relieved his stomach pain, and the pain in the shoulder gradually died away during the next fifteen minutes.

It was decided to endeavour to replace the stomach, and operation was performed on Aug. 7, 1919. The abdomen was opened by median incision in the epigastrium, and access to the under surface of the left dome of the diaphragm was secured by division of the left rectus muscle, the incision thus being T-shaped. The patient being a spare man with a wide epigastric angle, this incision provided very good access. On tracing up the

left border of the stomach, it was found to pass through the diaphragm just to the left of the aortic opening: on pulling on the viscus, it was found firmly anchored to the margins of the diaphragmatic opening by adhesions. These were torn through with difficulty, and the stomach, once it was freed from the margins of the opening, was easily withdrawn into the abdomen. About one-half of the viscus lay in the thorax. The opening, which would just accommodate the tips of two fingers, was then closed by five mattress stitches of chromicized catgut. The depth of the opening and the proximity of the aorta rendered the passage of these a little difficult.

The patient made an uninterrupted recovery; he was able to leave hospital at the end of three weeks, and was then taking his ordinary diet. He has remained fit and well, with the exception of some slight breaking down of his old empyema scar.

An almost identical case was recorded in the *British Medical Journal*, Sept. 27, 1919, and reference was made in that paper to two other cases. Nevertheless, the condition must be a rare one. Many abdomino-thoracic wounds were operated on during the war, and the mortality was high even after closure of the opening in the diaphragm; survival without closure must be very rare. Diagnosis is difficult unless the condition is borne in mind, and in all the above cases it remained undiagnosed for months. Once suspicions are aroused, a bismuth meal may be of assistance in confirming the diagnosis, though even this, as shown above, is not infallible, and the radiographers who had to do with the case at different periods gave different findings; one diagnosed a diaphragmatic hernia of the stomach, and the other a high paralyzed diaphragm with stomach subjacent. The old empyema and its resulting pleural adhesions obscured the radiographic appearance and led to confusion.

The approach from below was satisfactory, and access to the opening for freeing adhesions and closure was easy in this case, the patient being spare and the thorax rather short; in patients in whom the opposite factors were present, access from below would be very difficult.

Considering that three operations had already been performed across the thorax, and an empyema cavity had been draining for some months, it was extraordinary that the stomach had contracted no intrathoracic adhesions, and reduced quite easily into the abdomen once it was freed from the margins of the diaphragmatic opening. When operation was contemplated, it was feared that reduction from below would be impossible; nevertheless this route was determined on in view of the doubt as to the diagnosis, the intention being to supplement it by transpleural operation in case of necessity.

RETROPERITONEAL HÆMATOMA AFTER RADICAL CURE OF INGUINAL HERNIA AND VARICOCELE.

By CHARLES H. FAGGE, London.

General A., age 60, was seen with Colonel B. at an officers' hospital in London in January, 1916. He had been sent from the Indian Army in Mesopotamia to Bombay for the radical cure of a right inguinal hernia; this was done on Nov. 6, 1915. "The wound healed without complications by first intention; but during this time the patient's general condition was not very satisfactory. He had frequent attacks of abdominal pain, with nausea, and there was a rise of temperature to between 99° and 100° on Nov. 11 and 12. On Nov. 16 a fullness was detected in the right iliac fossa, and there appeared to be a soft tumour behind the ascending colon. Colonel C. saw him in consultation, and was of opinion that the condition was due to hæmorrhage following on the operation. The patient was treated by a course of calcium chloride and potassium iodide without much improvement. On Dec. 5 Colonel C. was again consulted, and he was still of opinion that hæmorrhage was the cause of the trouble. During the interval between the two consultations the patient's general condition was fairly satisfactory, but there was nearly always

a slight evening rise of temperature to 99°–99·2°, and obstinate constipation. He was able to get about in a wheeled chair; but on Dec. 1 there appeared a painful swelling in the left leg and thigh, and on Dec. 2 the right leg became swollen. This was ascribed to phlebitis. After the second consultation, on Dec. 5, it was agreed to explore the swelling; so an incision was made in the right flank and the peritoneum exposed; behind this a tumour bulged forward, and on the insertion of a trocar, dark sanious fluid escaped. After enlarging the opening, about 2 lb. of what appeared to be firm blood-clot was removed with the finger and a Volkmann's spoon. Some of the masses and a portion of the wall of the tumour were sent to the bacteriological laboratory for microscopical examination and report. Later the Director reported that the tumour was a hypernephroma.

"Since the exploratory operation the patient has improved to some extent in general health. The wound has almost healed, but there is some sign that the tumour is beginning to reappear. I might add that, after the operation, the tumour, from external appearances, had disappeared. . . . Recommended six months' leave to proceed to England for further treatment with radium."

The patient's condition considerably improved during his voyage to England, as testified by his wife, and on his admission to —— Officers' Hospital, Colonel B. found much difficulty in regarding him as suffering from inoperable malignant disease, for, though thin, his general aspect was good and his appetite excellent. Moreover, the right lumbar tumour had disappeared, and there was nothing abnormal palpable in the abdomen, except a gland the size of a walnut just above the right Poupart's ligament.

A consultation was therefore asked for, and the above is the history which was given us. As we were entirely unable to correlate the above report and the patient's present condition, a most meticulous examination was carried out. Amongst the possibilities which passed through my mind was that of the neoplasm being in some way connected with an undescended testis, and I proceeded to examine the right side of the scrotum to ascertain whether the testis was present and normal. The testis was present, and there was a small vaginal hydrocele; but while making this examination the patient gave me the key to the puzzle by remarking that a right varicocele had been removed at the time the hernia was operated on.

Further discussion with Colonel B. unravelled the whole mystery: the ligature controlling the upper end of the cut pampiniform plexus had come away, and a hæmatoma into the retroperitoneal tissue of the right iliac fossa had resulted. This would account for the abdominal pain, fullness in the appendical region, and constipation; it also gave a very probable origin for the 2 lb. of blood removed at the exploratory operation. One could only conclude that the pathologist's report was in error, and that the tissue examined was organizing blood-clot, or connective tissues infiltrated with blood, which those with experience will agree has always been recognized as a pathological pitfall.

As our view was only founded on surmises, it was decided to explore the right iliac fossa; this was done by Colonel B. on Feb. 11, 1916, three months after the hernia operation and two months after exploration. Colonel B. kindly allowed me to be present. Nothing abnormal was found except some thickening around the deep epigastric artery. General A. left hospital in March. He returned to duty, and his retirement from the Army at the end of 1918 was on account of age, and not in connection with health.

AN UNUSUAL WOUND OF THE ABDOMEN.

By J. B HAYCRAFT, Cardiff.

The following case is of interest on account of the position of the entry wound and the track of the bullet.

L.-Cpl. G. K., age 31, 2nd Suffolks, was wounded at 1 a.m. on June 1, 1918. He was admitted to No. 1 Canadian C.C.S. at 7 a.m. with a diagnosis of gunshot wound of right knee, and was placed in the 'resuscitation ward', as he was in a condition of profound

shock; pulse 128, almost imperceptible. He complained of pain in the abdomen, and sickness.

On Examination.—He had a very small wound on the outer side of the right knee-joint, midway between the patella and the popliteal space. There was a large area over the inner aspect of the right thigh, extending up into the iliac fossa, which was swollen and discoloured. The abdomen was rigid and tender all over, and there was marked dullness in both flanks. The bullet could be felt over the left rectus muscle midway between the umbilicus and the ensiform cartilage (*Fig.* 447).

The usual methods of combating shock were employed, including intravenous injection of one pint of gum solution. He remained, however, practically moribund all day, and, while there were other urgent cases waiting, operation was not considered justifiable. At 8.0 p.m., when these had been finished, operation was decided upon. His condition was much the same. Pulse 140, very feeble. Frequent vomiting. He was, however, fairly warm.

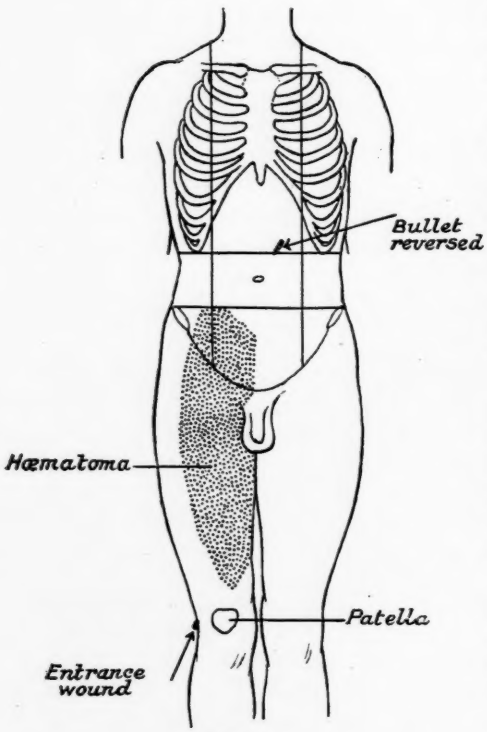

FIG. 447.

Operation.—Arrangements for blood transfusion had been made by Capt. Evans, R.A.M.C. Warm ether was administered by Shipway's apparatus. A long right paramedian abdominal incision was made; on opening the peritoneum, blood spurted out under pressure. The peritoneal cavity was rapidly mopped out, and bleeding started from some torn mesenteric vessels. As soon as these were secured by forceps, blood transfusion was commenced by Capt. Evans.

Three large perforations were found in the jejunum, and about a foot of the lower part of the ileum, together with its mesentery, was hopelessly damaged. The perforations in the jejunum were closed, two feet of the ileum resected, and end-to-end anastomosis was performed.

On examining the superior surface of the bladder, there was found a large hole, about the size of half a crown, with several pieces of bone adhering to it. These were removed, and the rent was closed by two layers of sutures.

The abdominal incision was closed in layers, and a suprapubic incision made down to the space of Retzius. The right pubic bone was found smashed, and there was a large extraperitoneal tear in the bladder, to which a rubber drainage tube was passed. The bullet was removed from the abdominal wall in the epigastric region, and was found to be completely reversed on its longitudinal axis.

The entrance wound and the thigh were left alone. The operation lasted forty minutes. 1000 c.c. of blood had been transfused, and the patient left the table greatly improved, with a pulse of 112, though still weak. The following day his pulse was 80, and his general condition very good; and progress was uneventful.

All urine passed through the suprapubic wound, and there was paresis of the muscles supplied by the external popliteal nerve, with foot-drop, necessitating a splint. On June 12, eleven days after operation, he was evacuated to the base.

The persistence of shock before operation was caused by two factors: (1) hæmorrhage, and (2) intraperitoneal tension. As soon as the latter was relieved and the lost blood replaced, recovery occurred in a very short space of time.

There was no evidence of peritonitis, during the operation or afterwards, in spite of the length of time which elapsed between the infliction and repair of the wound (nineteen

hours) and the severity of the intestinal injury. This must have been due to complete paralysis of the gut.

After-history.—He was discharged from the Army, Category B 3, on April 5, 1919. He remained well until August, when he began to suffer from cystitis. A few days later he became very ill, and a big fluctuating swelling appeared in Scarpa's triangle on the right side. This was opened, and offensive chocolate-coloured pus escaped. The bladder was washed out, the fluid escaping from the incision in the thigh. He gradually became worse, and died on Sept. 5, 1919.

Post Mortem.—" The bladder had given way at the old tear, forming a pouch in which there was a phosphatic stone protruding through a gangrenous hole the size of a shilling. This led into the abscess cavity underneath Poupart's ligament which had been opened."

I am much indebted to Mr. E. G. Renny, of Colchester, for kindly letting me know the after-history and the post-mortem findings.

TWO CASES OF STRANGULATED INTESTINE PARTLY CONTAINED IN HERNIAL SACS.

By HUBERT CHITTY, Bristol.

Case 1.—J. H., age 84, was admitted to the Bristol Royal Infirmary under my care on April 24, 1919, with the following history. For many years he had had a large reducible right inguinal hernia. Some twelve hours before admission this hernia had become painful and irreducible. The patient had vomited, and he complained of colicky abdominal pain and of inability to pass flatus.

When I saw him I was unable to reduce the hernia, but I noted that gurgling was obtained in the contents of the sac. The old man was also suffering from a severe attack of bronchitis. In view of this fact, and of his great age, I determined to operate under local anæsthesia. Two per cent novocain was employed, and the patient felt no pain throughout the operation, but chatted away the whole time.

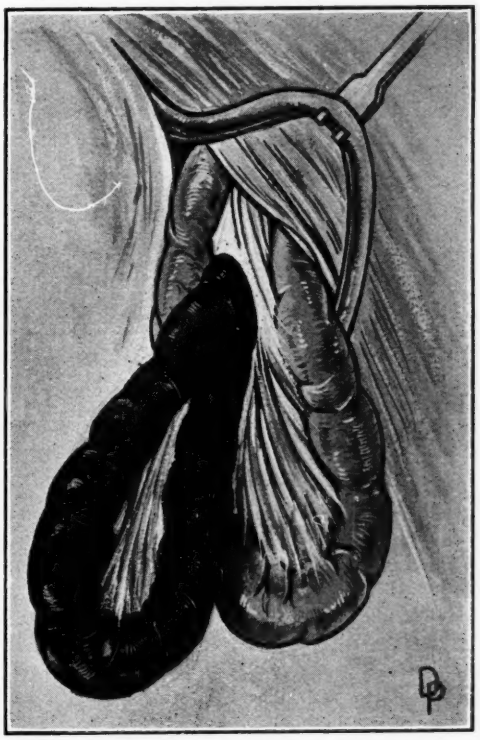

FIG. 448.—Right inguinal hernia.

On opening the sac much blood-stained fluid escaped. Two coils of intestine then presented; the anterior was bluish-black in colour, but its peritoneal coat was still shiny; the posterior loop was perfect lynormal in appearance. The neck of the sac was not tight, and more strangulated gut could readily be pulled down from the abdominal cavity. I prolonged my incision upwards and outwards, and found that strangulation was caused by the affected loop having passed through a hole in the root of the mesentery of the healthy loop. Reduction of this was readily effected. The contents of the hernial sac were then returned to the abdomen. Closure of the sac was complicated by the fact that a sliding hernia of the cæcum was present, its lower extremity together with the appendix forming part of the posterior wall of the sac.

The old man did not appear to be any the worse for the operation at the time, but on the following day he gradually passed into a state of unconsciousness and died towards evening. No post-mortem examination was permitted.

Case 2.—Mrs. L. P., age 81, was admitted under my care to the Bristol Royal Infirmary on November 13, 1919, with the following history. For many years she had had an irreducible right femoral hernia. Two days before I saw her this had become larger and more painful. Abdominal pain and distention had followed, with inability to pass flatus. Aperients and enemata had been given without avail.

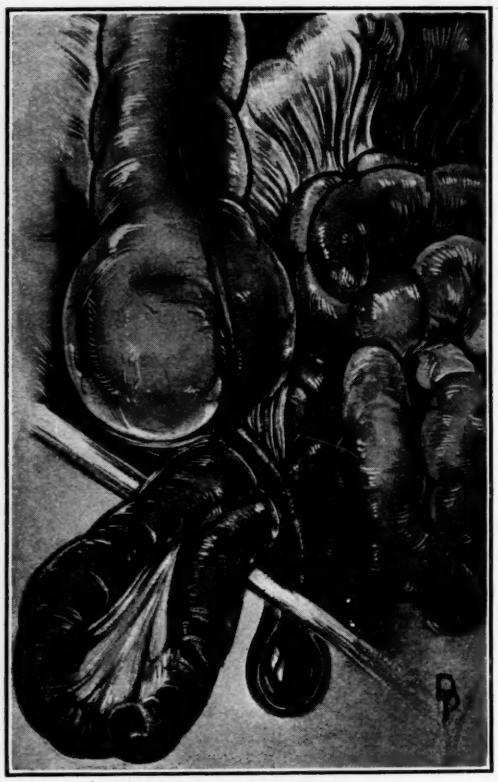

FIG 449.—Femoral hernia.

Condition on Admission.—The abdomen was greatly distended; coils of small intestine, arranged in typical 'beehive' pattern, were plainly visible through the attenuated abdominal wall. On the right side was a small tender irreducible femoral hernia. On the left side a small femoral hernia was also found; but this, though irreducible, was quite painless.

Operation.—The right femoral sac was cleared and opened, and was found to contain a purplish object about the size of a cherry. This, when pulled upon, proved to be the end of the appendix. It was not tightly gripped, and the strangulation was evidently not caused by the neck of the sac, but by some intra-abdominal condition.

The extremity, being bulbous, was quite irreducible. I next opened the abdomen by a vertical incision passing through the lower part of the right rectus, and found the following state of affairs: The appendix was bluish-black from base to tip, but its peritoneal coat was still shiny. Its tip was firmly fixed in the femoral sac. In this way it formed a band, and beneath it had passed a loop consisting of the terminal eight or ten inches of the ileum. This intestine was engorged and distended, and, by its pressure upon the vessels of the meso-appendix, had evidently cut off the blood-supply to the appendix.

I amputated the appendix, and withdrew it from the femoral sac, thus releasing the strangulated ileum. The femoral sac was next inverted, and, after ligation of the neck, was removed via the abdominal incision. Both wounds were then closed.

The patient made an uneventful recovery, in spite of her advanced age, and left the Infirmary in good health.

AN UNCOMMON INJURY OF THE CARPUS.

BY C. P. G. WAKELEY, LONDON.

DISLOCATION of the carpal semilunar bone is very rare, and I think a short account of such a case may be of interest.

W. A. H., a man, age 29, while driving a motor-bicycle and side-car near Birchington, Kent, on Sept. 29, 1919, was run into by a heavy motor lorry and thrown from

his machine. He landed on his outstretched right hand. He sustained several small cuts about the face and arms, and complained of pain in his right wrist. He was attended to by a doctor in Birchington, and then proceeded to London. When seen at King's College Hospital on Oct. 4, he stated that the pain in the right wrist was getting worse, and that he had some numbness in the thumb and in the index and middle fingers. On examination a definite hard lump could be felt under the flexor tendons at the wrist-joint, and there was a gap on the dorsum of the hand between the lower end of the radius and the second row of the carpal bones. There was some tenderness over the lower end of the radius. A radiograph was taken (*Fig.* 450), which disclosed a fracture of the styloid process of the radius; a fracture through the neck of the os magnum; dislocation of the scaphoid inwards; and dislocation of the semilunar forwards with rotation on its transverse axis. I consider that the dislocation of the semilunar was caused by the patient falling on his wrist while it was acutely dorsiflexed.

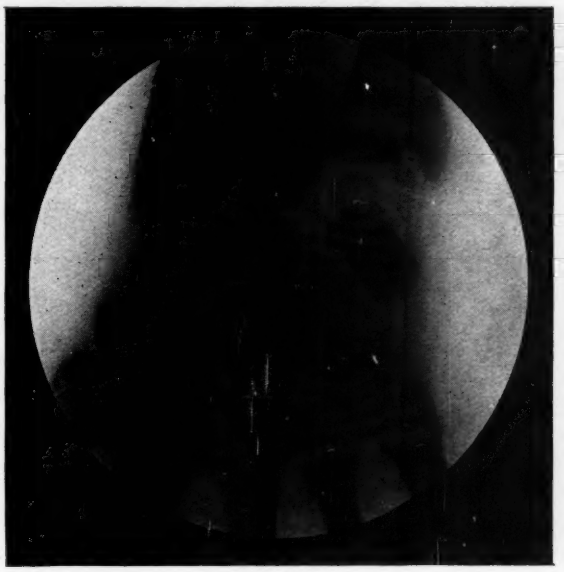

FIG. 450.

Von Lesser[1] explains such a dislocation in the following way: during dorsal flexion, the palmar apex of the semilunar is fixed by the strong palmar ligaments, and the dorsal apex presses against the head of the os magnum; in my case this produced a fracture of the latter bone. Then the dorsal apex slides along the head into the gap between the scaphoid and os magnum, and reaches the palmar side of the carpus, its lower concave surface being directed forwards; the bone may lie opposite its normal position or, as in the present case, higher up on the radius (*Fig.* 451), with considerable rotation.

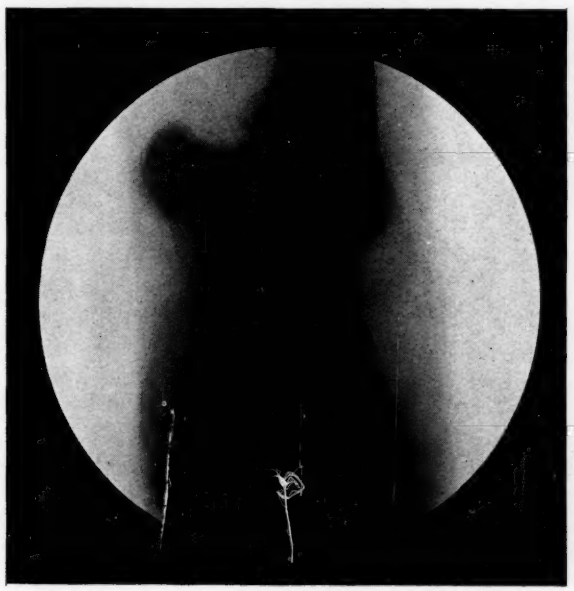

FIG. 451.

Reduction of the semilunar was attempted by manipulation, but unsuccessfully; but no great force was used, for fear of further displacing the scaphoid or separating the two fragments of the os magnum. Excision of the semilunar was therefore decided upon. I operated on Oct. 7, using a median incision just above the wrist. The median nerve was found to be pushed forward by the semilunar; this was displaced laterally and the bone excised. The palmar ligament uniting the radius and semilunar was not torn, but the ligament

uniting the semilunar and os magnum was ruptured. The wound was closed by a skin suture. A short palmar splint was applied for ten days, the hand being placed in a position of slight abduction; after a time a firm bandage was applied, and slight finger movements were encouraged. No massage was allowed till after the third week, when a second *x*-ray photograph (*Fig.* 452) was taken. The medial and lateral collateral ligaments of the wrist had contracted down well, and there was no displacement of the scaphoid. I am sure too early massage in a case of this kind would not permit the stretched ligaments to contract. The patient has now full movements at the wrist-joint and is quite free from pain, which is a frequent symptom of such injuries; I consider its absence in this case is due to the special care with which the after-treatment was carried out.

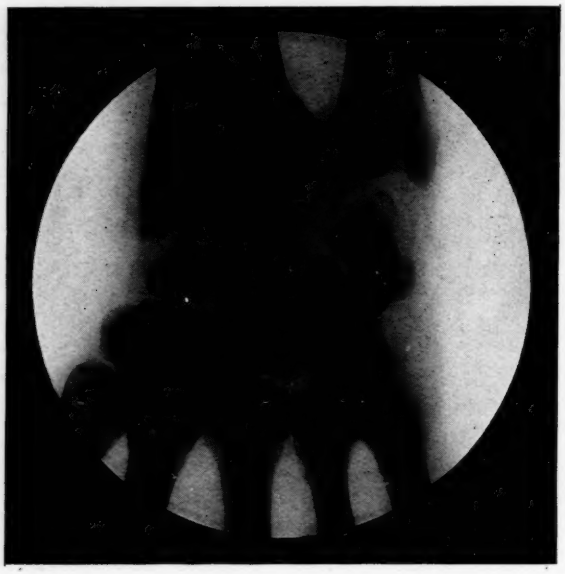

FIG. 452.

Fracture of the os magnum is very rarely seen, and few cases have been reported. Harrigan[2] reports a case confirmed by the *x* rays, and two cases have been reported in which the *x* rays have shown the fracture associated with that of other carpal bones.

My best thanks are due to Dr. R. Knox, Honorary Radiologist to King's College Hospital, for the excellent *x*-ray photographs which illustrate this case.

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[1] V. LESSER, *Deutsche Zeitschrift für Chir.* 1902, lxvii, 488.
[2] HARRIGAN, *Annals of Surgery*, 1908, ii, 917.

INSTRUCTIVE MISTAKES.

A SURGICAL ACCIDENT: NASAL PLUGS IN TRACHEA.

THE following account of an unusual accident should be worth recording as a warning to others. I recently performed a submucous resection of the nasal septum on an adult male patient under ether anæsthesia with a preliminary local application of cocaine and adrenalin. The operation was uneventful, and at its conclusion I put a plug in either side of the nose, to act as a splint and keep the flaps of mucous membrane in apposition. It has been my custom for some years to use, for this purpose, the finger of an ordinary rubber operating-glove filled with gauze. As the patient was being wheeled from the operating-theatre it was noticed that he was cyanosed and not breathing. His pulse was good. I started artificial respiration, but no air would enter the chest, and I then noticed that the plugs were missing from the nose. I did an immediate tracheotomy, but no air entered on artificial respiration. I then removed the plugs with Paterson's direct laryngeal forceps, through the tracheotomy wound; they were both impacted at the tracheal bifurcation. The patient recovered with artificial respiration, and had an uninterrupted convalescence.

Apparently the patient inhaled the two plugs by one sudden deep inspiration, which, in view of their size (a soft cylinder one inch diameter by three inches long), was an extraordinary proceeding. The lesson seems to be that it is unsafe to leave a plug in the nose unless anchored externally.

ACUTE ABDOMINAL SYMPTOMS WITHOUT INTRA-ABDOMINAL LESION: (?) ACUTE NEURITIS OF THE TWELFTH DORSAL NERVE.

B. L., age 7, was playing with other children at a seaside resort when his left side below the ribs struck the edge of a window-sill without much force and causing no immediate pain or illness. A few hours later the child felt ill, and complained of pain in the left lumbar region radiating forwards over the entire left abdomen. He was given a dose of medicine, and the bowels acted well the following day. The abdominal pain did not improve, and his temperature rose to 101°. On examination, twenty-four hours after the injury, the boy looked ill; temperature 102°, pulse 110, respirations 22; no cough, no vomiting; urine normal in quantity, no blood, sugar, or albumin present. There was marked rigidity involving the left rectus muscle, with tenderness and pain. The muscles of the lumbar region were also rigid, and there was most marked tenderness over the left renal region. In contrast, the right side of the abdomen was free from pain, tenderness, and rigidity.

In the absence of vomiting, constipation, or urinary symptoms, a diagnosis was not made, and the patient was re-examined twenty-four hours later. Tenderness and rigidity were more marked on the left side, and appeared more localized in the left renal region, but the urine remained normal. The temperature remained 102°. Patient was unable to stand erect owing to the fixed rigidity of the left lumbar and abdominal muscles. The hip was flexed. An exhaustive examination was made in consultation with a physician, and no pulmonary or other lesion could be found. It was decided to await further developments, as there was still an absence of vomiting, and enemata gave good results.

On the fourth day after the injury (which, it must be noted, was trivial and did not prevent the patient playing for some hours afterwards) the condition of the child was causing anxiety. He was in constant pain, the rigidity of the left rectus and lumbar muscles was more marked, there was acute tenderness in the left loin, and the temperature had risen to 103°. The facies suggested peritonitis. *X*-ray photographs were taken of the spine, ribs, and abdominal region generally, with negative results.

We felt certain there could be no gross lesion of the gastro-intestinal tract without vomiting, and in the presence of normal bowel action. There was a possibility of injury to the kidney, but with such acute symptoms blood in the urine would have been expected. Injury to the spleen was very unlikely in a boy 7 years old, and the unlikely chance of a slow hæmorrhage into the mesentery or omental folds was discussed.

On Aug. 29 the abdomen was opened through a long incision to the left of the mid-line. The stomach, intestines, spleen, liver, and left kidney were examined, and found in every respect apparently normal. There appeared to be some slight injection of the vessels in the parietal peritoneum. The abdomen was closed. Two days after operation the temperature fell and remained normal for ten days; the pulse-rate fell *pari passu* from 108 to 78. The patient was discharged from hospital apparently well.

Afterwards the pain returned, the temperature again rose, and for a fortnight conditions were much the same as before operation. A gradual improvement supervened, but it was not for three months after the onset of this perplexing illness that the patient recovered.

It is believed that the case was probably one of periostitis in the region of the costo-vertebral articulation, with acute neuritis of the twelfth dorsal nerve. This nerve, communicating with the first lumbar nerve in the psoas muscle, if injured, might produce spasm of the psoas and flexion of the hip, and its distribution to the internal and external oblique, transversalis, rectus, and pyramidalis muscles would account for the left-sided rigidity in the case under review. Near its origin the nerve passes outwards and downwards, under cover of the psoas, and between the external arcuate ligament and the quadratus lumborum muscle; hence the pain, tenderness, and rigidity behind. It should be mentioned in confirmation of the supposition of acute twelfth-nerve neuritis that the abdominal pain and tenderness radiated downwards over the crest of the ilium in the course of the lateral cutaneous (iliac) branch.

Dalziel (*British Medical Journal*, 1914) described cases of chronic twelfth-nerve neuritis on the right side simulating appendicitis; we have seen several of these cases; but this is the first instance of acute neuritis simulating the acute abdomen that has come to our knowledge, and the diagnosis is given with due reserve.

REVIEWS AND NOTICES OF BOOKS.

The Peritoneum. By ARTHUR E. HERTZLER, M.D., F.A.C.S., Surgeon to Halstead Hospital, Kansas. In 2 vols. Large 8vo. Pp. 870 with 230 illustrations. 1919. London: Henry Kimpton. 50s. net.

THIS is a work largely compiled from the author's experience during a period of twenty-five years' surgical practice, from experimental work done at the laboratory of the Halstead Hospital, and from the department of anatomy of the University of Illinois. Though there is a good deal of historical matter, and theories of other investigators are discussed in detail, the book is crowded with original work and ideas; and this is especially the case in the first volume. It is always invigorating to find a book containing much originality, but when it is combined with an essentially practical application, as is the case in these volumes, one is doubly grateful to the author.

The first volume discusses the more abstract problems, while the second deals with the practical aspects. The work begins with a full description of the physiology, histology, development, and gross anatomy of the peritoneum. The chapter on development is at once novel and illuminating, and the reason for the appearance of the various bands which have given rise to so much discussion is clear and convincing. The author points out that the peritoneal cohesions, which take place during the time the abdominal organs are undergoing changes of position and development, occur whilst the peritoneum is still composed largely of undifferentiated masses of cells, and he concludes it is safe to say that once a peritoneal surface is fully developed, morphologically and chemically, no further fusion takes place. In the chapter on gross anatomy there is given a complete description of the peritoneal folds, retroperitoneal fossæ, and herniæ, and the neural anatomy of the peritoneum is discussed in considerable detail.

Chapter V, and the subsequent chapters of the first volume, are concerned with wound healing and adhesions. These are dealt with very fully, and from the surgical point of view this part of the book is most instructive. The nature and genesis of adhesions is first considered, and it is shown how the less the infection the more dense and durable are the adhesions, and vice versa. As regards adhesions after suturing, the author points out that the less medicated the suture the less noticeable are adhesions, and he shows that iodized catgut produces an extensive adhesion formation by the chemical irritation of the peritoneum which it provokes. Though his contention is backed up by experiments, we doubt whether surgeons will entirely agree with this latter assertion. Anyway, material which causes a rapid adhesion of the apposed surfaces of peritoneum at the site of an anastomosis is rather beneficial than otherwise. As regards the prevention of adhesions, the author hits the right note when he emphasizes the beneficial effect of the utmost gentleness, the use of the minimum of foreign bodies of all sorts, either temporary or permanent, in the abdominal cavity, and the covering of all denuded surfaces as carefully as though they were unpardonable sins.

The second volume deals with actual diseases of the peritoneum. Every variety of affection is brought in, and is accompanied usually by a short historical sketch of the subject. The pathological and etiological aspects, the symptomatology, diagnosis, prognosis, and treatment are fully discussed.

A chapter is introduced on appendicitis because it is so common a cause of peritonitis, and is so intimately associated with the peritoneum in its own symptomatology. All other causes of peritonitis, e.g., the gonococcus, pneumococcus, etc., are treated with the same wealth of detail.

The book finishes with chapters on tuberculosis and tumours of the peritoneum. That on tuberculosis is lengthy, but does not, in our opinion, quite reach the standard of the rest of the volume, and there is no mention of the excellent and convincing work done by Stiles and others in Edinburgh. On the whole this book is a masterpiece in its completeness. It covers an immense amount of ground, and each item is criticized and discussed in all its bearings.

The general arrangement of the subject matter, and the clearness of the type and reproduction of the illustrations, are excellent. The bibliography appended to each chapter is another good feature, and will be of enormous help to anyone wishing to penetrate deeply into any matter relating to the peritoneum, or requiring to look up any reference on any peritoneal affection or experimental work relating thereto.

Facial Neuralgia and its Treatment. By J. HUTCHINSON, F.R.C.S., Surgeon to the London Hospital. Pp. 216 + xiii, with 37 illustrations. 1919. London: John Bale, Sons & Danielsson Ltd. 15s. net.

THOUGH the author published a monograph on this subject many years ago, and was awarded the Jacksonian Prize at the Royal College of Surgeons for an essay bearing the same title in 1915, this is the first edition in book form, and indeed is the only book of recent date dealing fully and comprehensively with this most distressing malady.

Having given a clear anatomical description of the 5th nerve and its relations in so far as they have a surgical application, the author goes on to deal with the causation of the different forms of facial neuralgia. The neuralgias due to abnormal blood states, true neuritis, and reflex causes he classifies as minor neuralgia; he reserves the term major, or epileptiform, neuralgia for the crippling condition usually referred to as tic douloureux.

A concise differential diagnosis between the various forms of minor neuralgia is given, and the appropriate treatment indicated; but almost four-fifths of the book are devoted to the major type. There is an excellent chapter on the symptoms of this malady, and points are brought out which differentiate it from the minor type.

Chapter IV deals with the nature and pathology of epileptiform neuralgia. The theories of neuritis and vascular degeneration are fully discussed, and disposed of. The author has to admit reluctantly that there is no known pathology as yet; even the ganglia removed and examined show no change in the majority of cases, though the subsequent history of the patients shows that the resection has effected a cure.

Rather more than 100 pages are employed in discussing treatment. The author emphasizes the importance of eliminating any peripheral cause in the mouth, nose, etc., but strongly condemns the practice of extracting healthy teeth. We think he might have enlarged on the value of *x* rays in determining the state of the roots of the teeth. Very valuable information can be obtained in this way.

A full account of the treatment by alcohol injections is given, and it is interesting to note that this method was first described by two Frenchmen, Pitres and Verger, in 1902; Schlösser, who is usually credited with the introduction of this treatment, did not publish his paper until 1903. At best these injections only give relief for eighteen months, often less, and they have to be repeated at intervals which become progressively shorter. Hutchinson's method of approaching the 2nd division of the nerve through the orbit gives a more direct face to the foramen rotundum than the more usual route by the cheek. The author also explains the difficult and risky operation of injecting the Gasserian ganglion. The dangers and difficulties of alcohol injections are clearly pointed out, as well as the methods of avoiding them.

A short description of the operation of neurectomy of the 2nd and 3rd divisions follows. However, the author is obviously of the opinion, and most surgeons will agree with him, that these methods are only second best, and patients should be encouraged to undergo the operation of resection of the ganglion at a much earlier date than is at present the case. Many are allowed, one might almost say encouraged, to endure the torture of this neuralgia for twenty or more years, because of the supposed dangers attached to the major operation. Hutchinson shows that these are largely fictitious: the mortality is slight, the danger to the eye negligible if the operation be done by his method of only removing the part of the ganglion concerned with the 2nd and 3rd divisions; the results, if not always permanent, are nearly so, and invariably relief is longer than by any other operation; and lastly, the disfigurement is nil, if the Hartley-Krause route be employed. He condemns Frazier's and Spiller's operation of turning over the sensory root to the ganglion, as this involves division of the ophthalmic root, and there follows either actual corneal ulceration or the constant liability to it; and besides, the ophthalmic division is never actually involved in trigeminal neuralgia; if pain be referred here, it subsequently disappears after removal of the 2nd and 3rd divisions and the part of the ganglion from which they spring.

A very useful chapter follows giving the results and complications of the operation, and an analysis of all the reported fatal cases.

The book closes with an appendix giving a few cases illustrating certain points, and a complete list of references and literature on the subject. We consider the volume an excellent one. It is full of instruction, and though the subject is dealt with exhaustively, there is no wearisome detail. The only adverse comment we have to make is a little carelessness noted here and there in the printing.

An Outline of Genito-urinary Surgery. By GEORGE GILBERT SMITH, M.D., F.A.C.S., Genito-urinary Surgeon to Out-patients, Massachusetts General Hospital; Captain Medical Corps, U.S.A.; Member of the American Association of Genito-urinary Surgeons and of the American Urological Association. Pp. 301. Large 8vo. Illustrations by H. F. Aitken. 1919. London: W. B. Saunders Company. 12s. 6d. net.

WE have read this book from cover to cover with interest and pleasure, and we commend it to our readers for the following reasons: it gives an excellent and up-to-date summary of the surgery of the genito-urinary tract; it is published in an attractive manner, being easy to read and light to

hold ; the author writes clearly and, without being dogmatic, gives an account of his own methods of investigating and operating in the various diseases discussed.

In our opinion the best chapters in the volume are those devoted to general considerations ; the remarks on endoscopy and cystoscopy are particularly interesting, and we cannot resist quoting from these. In discussing the value of posterior urethroscopy, the author writes, " In this connection it is easy to let the imagination run away with one's surgical common sense. Such procedures as washing out the utricle and catheterizing the ejaculatory ducts sound very effective, but unless one is an expert cystoscopist one should not attempt them. The case of gonorrhœa that cannot be cured by the simple measures of dilatation, lavage, and massage is a rarity. The chances of doing harm by more complicated treatment are many ". And again, writing of cystoscopy, " The value of cystoscopy admits of no argument. Without it diagnosis of genito-urinary disease is in many cases impossible. To-day the practice of renal surgery without preliminary study of each kidney by itself amounts to malpractice ".

The chapter on urinary antiseptics is by far the best that we have read on the subject, and is characteristic of the author's temperament ; this is frankly sceptical at times, and adds very greatly to the interest of his book.

The writer occasionally emits aphorisms, and these are generally good ; for example, " Once again let the rule be emphasized : Every case of hæmaturia, with the sole exception of those in which the hæmorrhage is clearly from the prostate, should be cystoscoped *at once* ".

The last chapter in the book, on impotence and sterility, is the most comprehensive and condensed summary of the subject we have met with ; Dr. Smith is eminently qualified to write well on this matter, the handling of which requires above all that indefinable quality called common sense.

At the end of each chapter a short bibliography is given ; the works referred to appear to be those from which the author has derived benefit, and which his readers may consult if they wish to delve more deeply into the particular subject.

After this encomium, it may seem ungrateful to refer to some faults ; but the book will be improved if these are deleted. On page 253 the last line contains the word 'produce', and this should obviously have been 'reduce'. The illustrations, which are on the whole good, are rather spoilt by the fact that two of the skiagrams have been inserted upside down, pages 250 and 252 ; on page 221 the value of the *x*-ray picture is diminished by the omission of the skiagrapher to mark a right and left on his plate.

In conclusion, we wish to tender our congratulations to Dr. Smith for having shown that a modern work of scientific value can be produced in a form which is pleasant to read. Personally we have found several railway journeys materially shortened by the perusal of this book.

Diseases of the Nose and Throat. By HERBERT TILLEY, B.S., F.R.C.S. Fourth edition. Demy 8vo, with 74 plates and numerous illustrations in the text. Pp. 844 + xx. 1919. London : H. K. Lewis & Co., Ltd. 25s. net.

PROGRESS in laryngology and rhinology during the eleven years since the last edition of this manual was published has necessitated extensive alterations and additions, some extra 300 pages being required in order to cover recent work.

The scope of this manual still remains essentially practical, embodying the results of the author's personal experience rather than the views of others. The result obtained must necessarily, therefore, depend on the amount of practical experience on which the opinions are based, and on the breadth of outlook with which the results of this experience are weighed. To those who are familiar with the former edition it will suffice to say that the present volume maintains the high standard there set up.

The author's experience is extensive, and he has avoided the narrow outlook which is unfortunately not seldom the result of modern specialism. The reader who bases his practice on the views and methods here given can rest confident that he is giving his patients the best that our present knowledge allows.

Among the sections devoted to recent work, that on endoscopy is particularly good. The work has been brought thoroughly up to date, such matters as the intranasal operation on the frontal sinuses, lachrymal sac, and the pituitary body being adequately dealt with.

A few misprints require correction. On page 21, in the description of Holmes' pharyngoscope, 'mirror' should read 'prism'. It seems possible that the author's long experience with posterior rhinoscopy has led him to neglect this very useful little instrument. On page 46, 'falted' should read 'felted', and page 267 ends incoherently.

The illustrations are profuse in number, and well chosen and reproduced.

Surgery of the Lung and Pleura. By H. MORRISTON DAVIES, M.A., M.D., M.C. (Cantab.), F.R.C.S. Quarto. Pp. 260 + xxiv, with 80 illustrations. 1919. London : Shaw & Sons. 25s. net.

THIS is one of the most important contributions to thoracic surgery that have been issued for a long time. It is the outcome of much original thought and observation, and records the considerable

development which has occurred since the publication of the works of Fowler and Godlee, Sauerbruch and Garré.

An interesting chapter is that devoted to intrapleural pressures and the best apparatus to use for the control of open pneumothorax. The author concludes that intratracheal insufflation is the best apparatus, and that it supersedes any of the forms of pressure chamber.

The injuries and diseases of the lung and pleura to which surgery is applicable are dealt with carefully, but perhaps the most thoughtful chapter is that given to pulmonary tuberculosis. Any direct attack on a diseased area of lung is deprecated, the author stating that the modern method of surgical intervention is to produce collapse of the whole or part of the lung so as to obtain immobilization of the diseased organ, obliteration of cavities, and prevention or arrest of hæmorrhage. Nitrogen displacement is the method of choice when collapse of the whole or greater part of the lung is required. The indications, contra-indications, and technique of the method are given in detail. Other methods of obtaining the same end are also discussed, namely rib mobilization, local replacement by tumours, and section of the phrenic nerve causing paralysis of the diaphragm. By the combination of the forces of medicine and surgery it is claimed that the whole prognosis of the disease has been revolutionized.

Rose and Carless's Manual of Surgery. By ALBERT CARLESS, C.B.E., M.S. Tenth edition. Demy 8vo. Pp. 1562+xii, with 614 figures and 33 plates (16 coloured). 1920. London: Baillière, Tindall & Cox. 30s. net.

THE last edition of this book appeared in October, 1914, since when it has been reprinted five times and now appears in revised form. The chief new feature of this edition is the inclusion of various matters related to war surgery, and an attempt to relegate these to their proper position in civil practice. The treatment of infected wounds by Dakin's solution, B.I.P.P., flavine, and salt; a consideration of 'orthopædic' principles; and a description of traction and suspension methods of treating fractures, are the chief of these new subjects. The author is apologetic about the increase in size necessitated by these additions, and speaks of a future time when he may be able to make his book assume smaller dimensions. We venture to think that before this can be done a decision will have to be made as to whether the book is to be an encyclopedia containing a reference to everything, or a practical guide representing only those ideas and methods which the author would teach to students.

The sections dealing with the treatment of infected wounds observe a nice balance between commendation and criticism, and the advantages of the four chief new methods are fairly stated, with the general reservation that mechanical cleansing is, after all, the prime necessity.

The chapter on the use of physical agencies in surgery covers the ground of massage, electrotherapeutics, light, heat, hydrotherapy, and radio-active agents. It is an excellent summary of these methods, but it suffers from the necessity of brief statements, e.g., that "sarcomata are amenable to radiotherapy to an even greater extent than cancers. It is desirable to implant the radium into their substances, and cessation of growth often follows. Periosteal or round-celled sarcomata of the long bones may be thus treated and thereby amputation avoided" (p. 313). Surely such a statement is far too optimistic and, taken by itself, quite misleading.

The chapter on fractures contains a great deal of additional matter, all of which is good. We must, however, express regret that the treatment by extension is placed in small print instead of being presented as the first-line method of choice, whilst plaster-of-Paris, splints, and operations bulk so largely as to be regarded as of the chief importance. It is true that a wise conservatism is taught in regard to operative treatment of fractures. "Where effective extension can be made and maintained, an open operation may almost be looked on as a confession of insufficient knowledge of inefficient apparatus on the part of the surgeon". If this be so, then the extension methods should be described in large print and the operative methods in small.

There is a good description of treatment of fractures of the thigh and leg bones by means of the various types of skeleton splints, the methods of Pearson being well illustrated.

The author is to be most warmly congratulated on having so promptly brought this classical text-book up to date; and we feel sure that it will long maintain its position as the best of its kind in the English language.

A Text-book of Urology in Men, Women, and Children, including Urinary and Sexual Infections, Urethroscopy, and Cystoscopy. By VICTOR COX PEDERSEN, M.D., F.A.C.S., Major, Medical Corps, U.S.A. Pp. 991, with 362 engravings, of which 152 are original, and 13 coloured plates. 1919. London: Henry Kimpton. 36s. net.

IN the preface to this book, the author states that the actual production of the manuscript and illustrations required four years of consistent and concentrated effort; we can quite well believe this, for the volume contains a vast collection of facts relating to the surgery of the genito-urinary tract. The book is well published; the printing is clear, and the illustrations are above the average.

The most striking feature about this volume is its lack of proportion; the first twelve chapters (681 pages) are devoted to the diseases of the urethra; this leaves only five chapters (281 pages)

for the discussion of diseases of the bladder, prostate, ureters, and kidneys. The reason for this disproportion seems to us to lie in the author's interest in the subject of gonorrhœa; this disease he discusses in much detail.

We believe this book will be found most useful by those in charge of venereal clinics, but they must be prepared for some serious reading; the author's style is of the heavy artillery type. A much more grievous defect of this work is the large number of errors of punctuation; the meaning is thereby rendered at times obscure, and sometimes is actually distorted. To give two examples: on page 342 we read, "This is often the outcome of irritation, with instruments of edematous stricture"; and on page 344, "In uncomplicated cases the granulation tissue around the stricture if in the anterior urethra may cause a diurnal frequency of once in a few hours in average cases only slightly above the normal". Such sentences as these are rather irritating and greatly detract from the value of the book.

There is one other point which we should like to criticize, and that concerns the author's fondness for elaborate classifications; stricture of the urethra is divided up into eleven varieties; *cui bono*, unless to provide questions for surgical examinations? Surely the only adequate reason for a classification is to make the student's task easier.

Inguinal Hernia, the Imperfectly Descended Testis, and Varicocele. By Philip Turner, M.S., F.R.C.S., Assistant Surgeon, Guy's Hospital. Large 8vo, pp. 104 + viii, with 22 illustrations. 1919. London: J. & A. Churchill. 9s. 6d. net.

The object of this little book is to advocate certain slight modifications introduced by the author in the operations for the treatment of the above affections. So many operations for the cure of these common affections are now done by so many surgeons that is open to question whether it is worth while to devote so much space to so small a subject; but the book is well written, and contains a good deal of useful material usually found in the ordinary clinical lecture.

With regard to the suggested operation for inguinal hernia, it is a little surprising to find no reference to the one known, we believe, as Andrews' operation, and very widely practised in America, which somewhat resembles that of the author, though it is a good deal preferable to it in practice. In this operation the incision through the external oblique aponeurosis is made parallel to but above the centre line of the inguinal canal, so that the portion of the aponeurosis lying over the cord is not damaged at all. This certainly renders closure of the incision in the aponeurosis at the end of the operation easier, and no damage is done to the ring or the intercolumnar fibres.

In dealing with imperfectly descended testicle, the author's views as to the functional capacity of the retained testis are hardly in accord with those of surgeons who have had most experience of the condition. If the operation for replacement be performed skilfully and at the right time, the development of the organ is surprisingly good. The risk of impotence from retained or misplaced testis is certainly overrated: testes have been removed from the groin of a patient of over 55 that showed abundant active spermatozoa. The author seems to lean towards the plan of placing the imperfectly descended testes in the abdominal cavity under certain circumstances. Of this method he has probably not had any large personal experience, or he would lay stress upon the very painful and possibly dangerous complications that may ensue when the testis is carried just inside the internal abdominal ring.

The merits of the operation he advocates are not very obvious. In the first place the method in common vogue, especially if the testes be fastened to the well-known wire frame, is very simple, and quite satisfactory if it be properly done. Since it was first introduced, ample time has now elapsed to show the end-results, which are all that could be wished for. In the second place it seems a very hazardous procedure to pass the testis through a hole in the scrotal septum narrow enough to prevent the organ slipping back through it again. The result of such pressure upon the development of this delicate organ might well be disastrous.

In summing up "the reasons for the disappointing results of orchidopexy, as performed in the usual way", the author betrays a curious want of knowledge of a really well-performed operation. Out of six reasons which he gives, five should never occur if the operation be properly done, and the influence of the sixth, viz., an undeveloped condition of the affected side of the scrotum, is purely imaginary. There are many scores of cases available to prove this. He says further that "it has also been recommended, when the vas is unduly short, that the epididymis may be dissected away from the testicle with a view to providing additional length, so that the globus minor is uppermost". If such a doctrine has been recommended, it is one which carries its own condemnation on the face of it; but the plan of freeing the vas from the back of the epididymis, so that the testis is turned bodily upside down, is a most valuable plan which has been used many times with perfect success when no other method would allow the testis to be brought down to the bottom of the scrotum without tension—as should always be the case if a good result is to be looked for.

The operation for varicocele is a slight modification of the standard method. It was designed to avoid minor complications of a very trivial type.

Plastic Surgery: its Principles and Practice. By JOHN STAIGE DAVIS, M.D., F.A.C.S. Pp. 770 + xv, with 864 illustrations. 1919. Philadelphia: P. Blakiston's Son & Co. London: Henry Kimpton. Price 42s. net.

"THE time has come for the separation of plastic surgery from the general surgical tree". Such are the words of an enthusiast with whom, after perusal of his book, we are entirely in agreement. The ultra-specialization of surgeons may have its drawbacks, but it also has advantages, which, to the patient at any rate, are of considerable value. There is much room for good surgical plastic work in the varied injuries, diseases, and deformities of the face and body which occur in practice. A deformity, especially of the face, is much more damaging to the sufferer's morale and efficiency in life than is usually understood by the profession. Many of us have had opportunities to study the psychology of patients suffering from war injuries of the face, and nothing is more striking than the improvement in general efficiency so often seen with successful reconstructive surgery. Even the correction of a crooked or too large nose should not henceforth undergo the veiled sneer of 'beauty doctoring'. Success here means as much increased efficiency as follows the average appendicectomy.

Dr. Staige Davis emphasizes the point that such success needs painstaking forethought, constructional imagination, absence of surgical trauma, gentle handling of the tissues, and a *flair* for cutting flaps, together with all the other necessary virtues of a modern surgeon. The author has made a very comprehensive and common-sense survey of the subject, with its literature, and added to it his own successful experience.

The difficulty of the subject lies in the fact that so many methods are described without good records of the operative results. No surgeon describes an operation without giving his statistical results: the rhinoplastic surgeon's optimism in describing a new nose as a good one cannot be accepted without unimpeachable photographic proof. It is unfortunately easy to photograph at an angle and with a special light which will either magnify a prior deformity or minimize post-operative defects. Who could fail to recognize the vast difference in coloured texture presented in life by a nose made from the forehead and one from the arm or chest? Yet equally good results may be apparent in a photograph. On the other hand, scars may be more marked than in life. Sometimes the surgeon does himself injustice by recording his results too early, before he has allowed time to have its beneficial effect. Contrarywise, a nose that is not properly lined with skin will often look well for a few weeks after an operation, but will subsequently contract and retract.

The chapter on 'General Considerations' is of considerable value as an epitome of various plastic methods. Our only criticism is that numerous methods are described diagrammatically and otherwise the results of which are not recorded by actual cases. We also disagree with the author when he states that life-size wax models, painted, are the ideal graphic record, because the enthusiasm of the artist often vitiates the accuracy of his representation.

The chapter on prosthesis has many good points, supported by actual results. We particularly agree with the author's criticism on the use of celluloid and other buried prostheses, and with his strong condemnation of the paraffin injection.

In the section on the transplantation of skin, great care has been taken in giving accurate descriptions of methods and their results. We think, however, that sufficient importance has not been assigned to the methods of applying Ollier-Thiersch grafts on a mould such as is described by Maszkowicz and Esser. This method, in our experience, has given more astoundingly good results than any other way of applying the graft. The mould can be applied in any position and to any shape of raw area. With the cutting of good large grafts, applied on a mould, one now expects to see an area grafted as by a successful aseptic flap operation. An excellent description is given of the author's practice in Wolfe grafting. We do not think, however, that he is using the best methods, either from a practical or theoretical point of view, as, in our opinion, the Wolfe graft, when applied to the raw area, should be sutured very accurately in order to give the tension of normal skin. No slits or punch holes should be made in the graft, as they are entirely unnecessary. In other respects the profession should be really grateful to the author for his admirable summary of the methods of skin transplantation.

In regard to the transplantation of other tissues, the author's praise of cartilage as a supporting structure is good, but we would like to have seen a more definite statement as to the uses of the bone graft. His accounts of his experiences with fat grafts are eminently true, and his poor results with free grafts with mucous membrane are borne out by many other workers' experiences. In place of mucous membrane, thin Thiersch grafting is equally good, except perhaps in the eyelid.

The important chapter on pedunculated flaps gives much valuable information, but we are sorry to see such an unpractical diagram as appears on page 122, on which are depicted five flaps, only one of which should ever be used in plastic surgery. It is a pity also that the tubed pedicle was not annunciated before the book was written, as the English method of tubing the pedicle of a flap has solved almost 70 per cent of the difficulties inherent on transplanting skin from a distance. We are in strong agreement with the author in his emphatic advice to avoid any rough handling of the flaps.

A long chapter follows on the treatment of wounds, much of which is not pertinent to the subject of plastic surgery. The bibliography is voluminous, and in our opinion somewhat unneces-

sary. It would appear that the author, having decided to insert a chapter on this subject, found himself, with his usual thoroughness, bound to follow it to the end; but we do not think that these sixty pages have been well-spent labour, neither are we in much sympathy with the ordinary treatment of intractable ulcers and varicose veins which have been discussed in the next twenty-five pages, the only interesting paragraphs of which are those in connection with the use of the grafting method for their cure.

A long chapter on malformations gives an insight into many interesting conditions, of which perhaps the reader has not seen more than a small percentage. The treatment of the cases illustrated seems sufficiently satisfactory to speak for itself. The chapter on harelip gives no evidence that this condition has been conquered by the plastic surgeon. Especially to be commended are the drawings by E. Fry of the Thompson operation as done at the Mayo clinic. The rest of the chapter, devoted to cleft palate, follows the usual lines. However, the author has given a good *résumé* of modern practice. The three chapters on genito-urinary malformations are exceedingly good and well planned. The general surgeon will find in them a very carefully recorded epitome of the subject. In plastic surgery of the eyelids, the best work the author has given us is that in regard to cicatricial ectropion, in which his whole-thickness grafts show remarkable results. The rest of the chapter shows methods clearly defined and described, but we would that further results could demonstrate which of the various plans is the best to adopt in particular cases. A very complete chapter on otoplasty gives all the best-known methods. Some of the results shown are exceedingly good, and the chapter leaves little to be desired.

It is in the chapter on rhinoplasty, perhaps, that the author is most expansive. His description of the development of the various methods is excellent, but many of them might have been mentioned merely to be discarded. That on page 456, for instance, should not be allowed to find its way into a text-book, as it is doubtful whether any nose could ever have been made by such a procedure. We are glad to find the value of the skin lining of the new nose upheld by so experienced a surgeon. There is no doubt, in our opinion, that the efficiency and cosmetic results of a rhinoplastic operation depend far more on the provision of an adequate and correct skin lining than on the outside covering. The use of the forehead as the outside covering is to be commended, but the author's pictures show flaps taken unnecessarily near the centre of the forehead, thereby increasing the secondary deformity. We are pleased that he notes the value of the Keegan-Smith operation, and to see his pronouncement of the importance of rib cartilage as a substance, *par excellence*, for supporting the nose. The rest of the chapter is devoted to descriptions of various methods, many of which the author justly condemns as unpractical. The author has rightly included many of the ordinary and often described operations, but it would be a real help to the surgeon if he could see the results of such methods on actual cases, and thus discriminate between them.

In the chapter on the reconstruction of the mandible, it is obvious that the author has not had great experience with the free bone graft, which in French, British, and German hands has given 80 to 90 per cent of successes. In the description of the lip operations, the author very wisely insists on providing an adequate skin lining for the new portion. He shows good results of certain types of deformities of the lip, but some diagrams have crept into the text which, in our opinion, are quite impossible. Such an operation is that described on page 531, and one wonders why such a method should be perpetuated, however illustrious the name it bears. The reader will find, however, so much of value in studying the author's own cases, that he may well neglect methods which should be relegated to the scrap-heap. Very similar praise and criticism applies to the chapter on the cheeks. There is much good material in the operations for parotid fistulæ and for facial paralysis. In the last chapter many cases are illustrated showing the application of plastic surgery to the extremities, and this will be found of great value.

In conclusion, we can hardly conceive any general surgeon not having this book at his elbow, not only because of its admirable critique of the world's methods, but also on account of the very valuable experiences from the author's own practice.

Surgical Operations: a Text-book for Nurses. By E. W. Hey Groves, M.D., B.Sc., M.S., F.R.C.S. Large 8vo. Pp. 255+viii, fully illustrated. 1919. London: Henr Frowde and Hodder & Stoughton. 21s. net.

Nurses who are wishing to learn the principles of surgical technique and to read a concise account of the chief major operations will do well to acquire this book. It will be specially helpful for theatre nurses.

After an excellent chapter on general technique, the author gives accounts of typical operations on every part of the body, with plenty of excellent illustrations to help the reader. At the end of the book, forty pages are devoted to illustrations of surgical instruments.

Some errors in spelling have crept in: e.g., 'scizzors' on page 232, 'mucous' on page 118, and 'aneurismorrhaphy' is spelt as two words on page 52. Catgut is stated to be made from the peritoneal coat of the sheep's intestine; surely it should be *submucous* coat.

The section on liver abscess pays no attention to the usual transcostal route, nor do we think

that packing the cavity of a liver abscess with gauze is ever preferred to the insertion of a tube. We also think that reference should have been made to the modern treatment of femoral hernia by the inguinal route.

The book is very well produced, with clear type and splendid illustrations, and should serve a useful purpose.

The Surgery of Egypt. By FRANK COLE MADDEN, O.B.E., M.D., F.R.C.S., Professor of Surgery in the Egyptian Government School of Medicine. Large 8vo. Pp. 394 + xxviii, with 63 plates and 238 illustrations. 1919. Nile Mission Press, Cairo.

MR. MADDEN in his preface states that his book is intended to be read, at least by students, together with Rose and Carless's *Manual of Surgery*. This advice is very necessary, as the book by itself would scarcely stand as a text-book of surgery; it is rather a running commentary on surgery generally, as affected by the climate and social conditions of Egypt. For the senior student, however, the inclusion of the somewhat elementary directions with regard to technique, found in the early pages of Chapter X on the surgery of wounds, etc., appears to be out of place, and would be more in keeping with a treatise on surgical nursing. The book claims to represent surgery as practised at the Kasr-el-Ainy Hospital and copious extracts are made from the writings of Drs. Ferguson and Day and of Mr. Richards.

The chapters of the greatest interest to the practitioner in England are those on splenomegaly and on bilharziosis. In the case of the latter, the author rightly claims that the story is clearly interwoven with the history of the Kasr-el-Ainy Medical School, and it is only fitting that the discovery of the intermediate host by Leiper should have been worked out in Egypt, although, perhaps, the first hint came from Japan. A very clear account is given of Leiper's work, with some excellent illustrations from the same source. What is also of great interest to clinicians are Captains Lawton and Fairley's accounts of cases of recent infection, chiefly intestinal, amongst Australian soldiers. Evidence of this character can seldom be obtained from the native population, who have been exposed to infection from childhood. The whole question of bilharziosis has now for English practitioners a closer interest, as such cases cannot fail to occur occasionally amongst troops returning from Egypt. Curative treatment is only lightly touched upon, and evidently the Kasr-el-Ainy Hospital had not then much first-hand knowledge of intravenous injection of tartar emetic.

Mr. Madden has compiled an interesting book, and one that should be of considerable utility to any surgical practitioner who might find himself in Egypt. We would respectfully submit that such expressions as 'spotting,' and the slang equivalent for the penis sheaths worn by Kaffirs, should scarcely be found in a serious text-book; while the expression 'very aseptically' is an example of loose English and of looser thinking to which medical writers appear occasionally to be liable.

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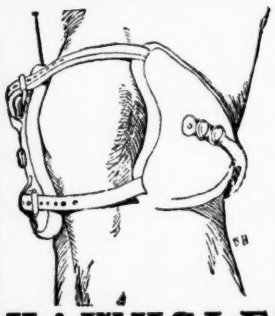

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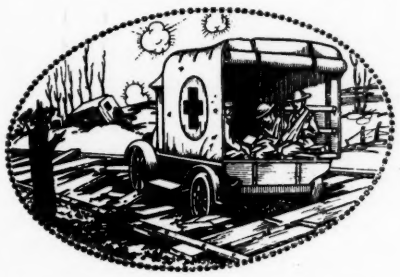

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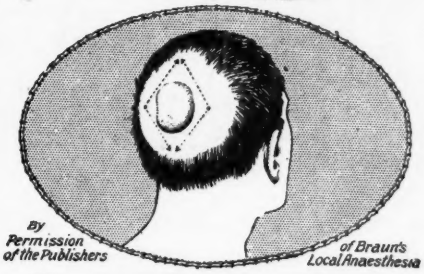

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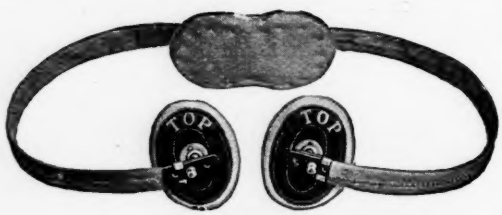

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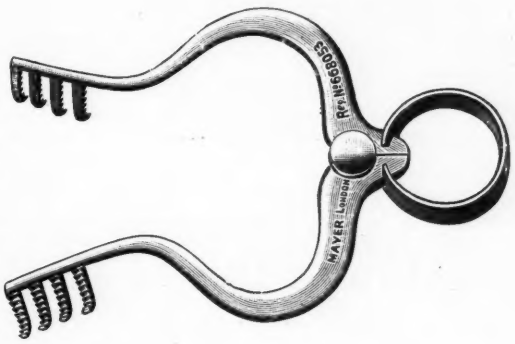

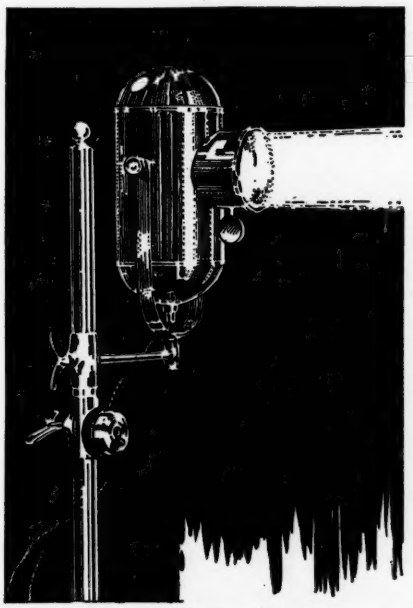

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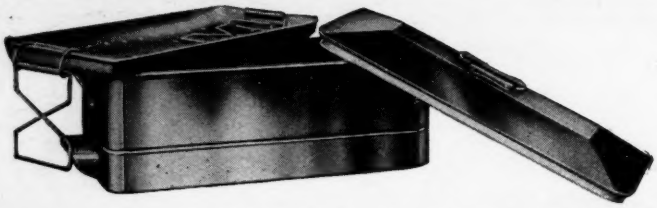

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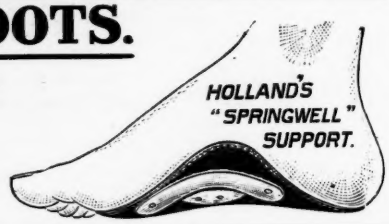

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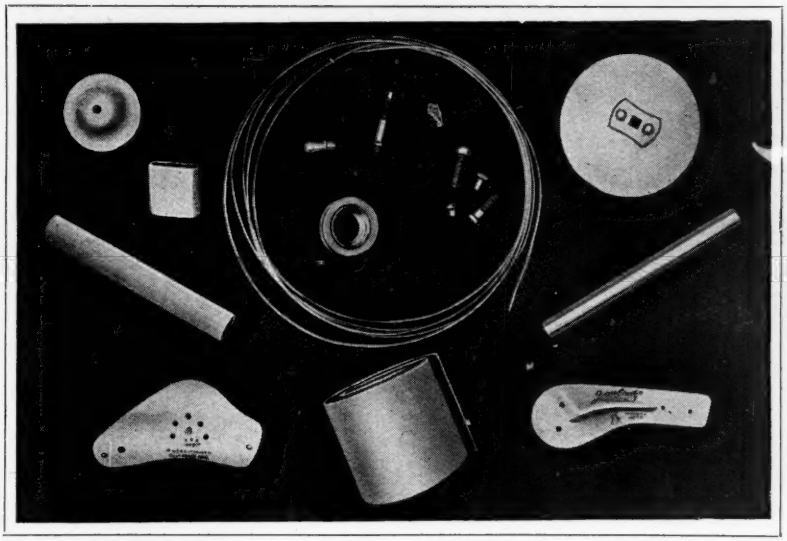

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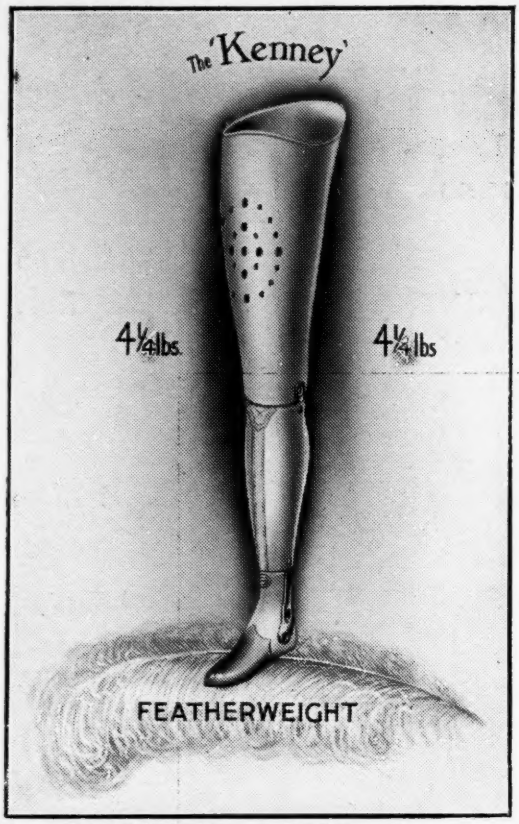

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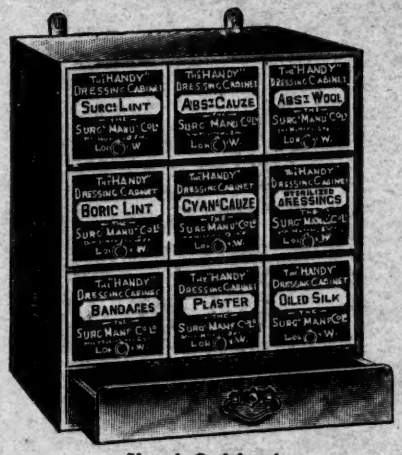

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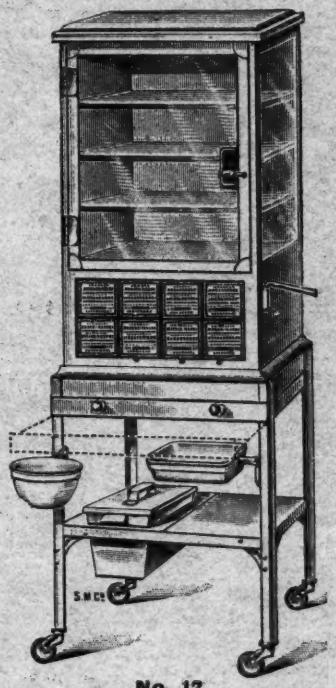

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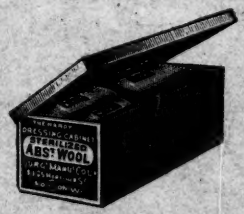

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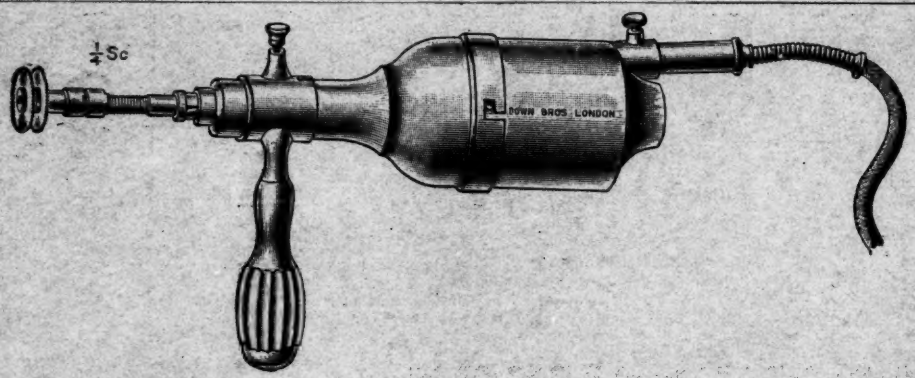

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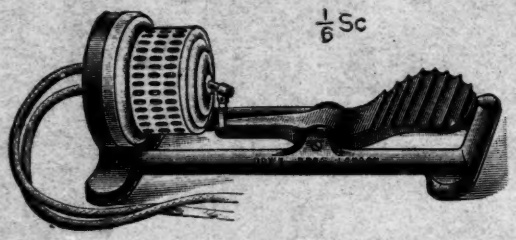

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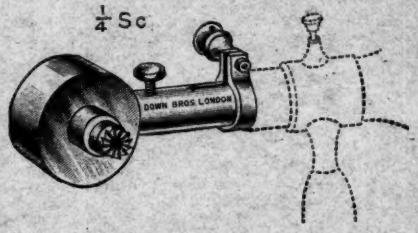

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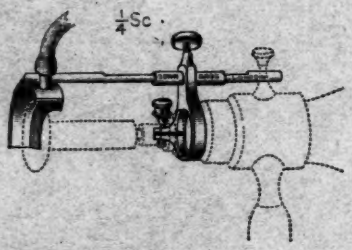

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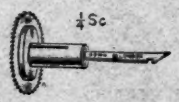

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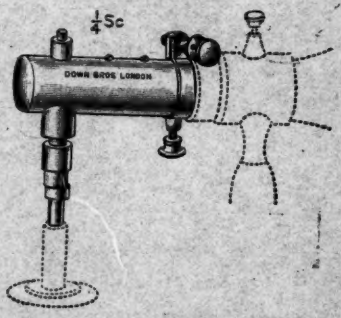

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